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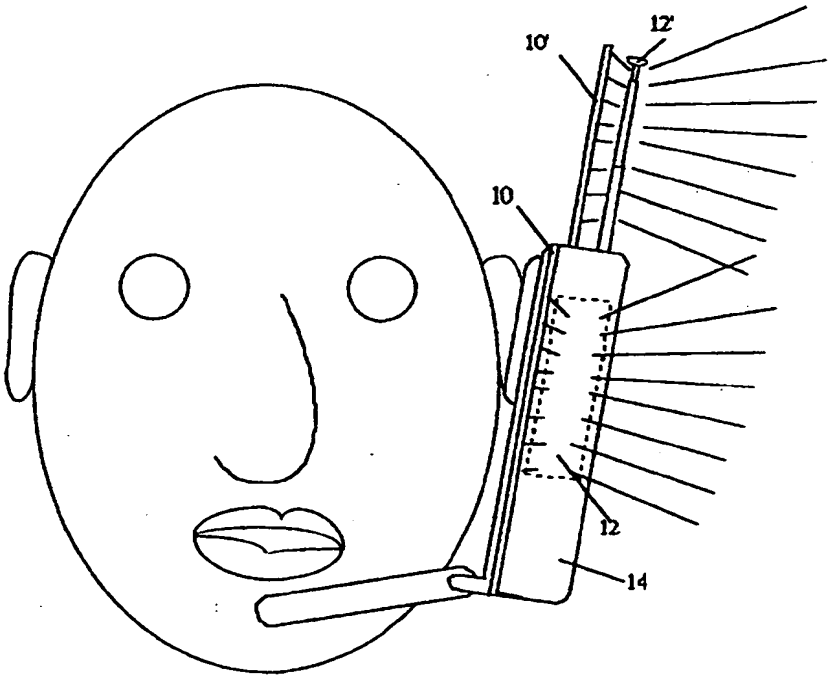
(54) Title: RADIATION SHIELDING APPARATUS FOR A RADIO TRANSMITTING DEVICE

(57) Abstract

A radiation shielding apparatus for a transmitting device, such as a cellular phone (14). A radiation shield (10, 10') is disposed between a radiation component (12, 12") and a user to prevent unwanted exposure of the user to emanating radiation from the radiation emanating component. The cellular telephone radio transmitting device may be a hand-held cellular telephone (14), and the radiation emanating component may be an internal (12) or external antenna (12') or any other electromagnetic radiation source, such as a transmitter. The radiation shield can be retrofitted to an existing cellular telephone, or may be designed specific for different models of cellular phones. The radiation shield can absorb, block and/or reflect electromagnetic wave radiation to shield the user of such cellular telephones from unwanted and possibly harmful exposure to electromagnetic wave radiation.



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RADIATION SHIELDING APPARATUS FOR A RADIO TRANSMITTING DEVICE

BACKGROUND OF THE INVENTION

The present invention pertains to a radiation shielding apparatus for a radio transmitting device. More particularly, the present invention pertains to a radiation shielding apparatus for protecting a user from radiation generated by a hand-held cellular phone.

It is well known to shield circuitry from electromagnetic wave radiation by providing a layer of electromagnetic wave shielding material between an electromagnetic wave source and the circuitry to be protected. Conventionally, such shielding is provided to prevent the influence of electromagnetic wave noise from affecting the protected circuit.

Cellular radio telephones have recently become well known devices. A cellular radio telephone is generally a portable unit for communication over hard wire phone lines by transmitting electromagnetic wave signals between the mobile cellular phone and stationary transmission/reception units known as "cells". These cells are connected with the hard wired telephone network, usually through a direct mechanical link. Thus, a user of a cellular phone is not confined by the traditional limitations of being mechanically linked with the hard wired telephone network. Rather, the user of a cellular phone has mobility due to the radio transmission of the electromagnetic wave signals between the cellular phone and the cells. The user is able to communicate via the hard wired telephone network, as long as the cellular phone is within range of an appropriate cell.

A typical cellular radio frequency is between 800 and 900 megahertz. In other words, in order to communicate via the cellular telephone, the cellular telephone receives electromagnetic wave radiation in the frequency range between 800 and 900 megahertz from a cell, and also transmits electromagnetic wave radiation at this frequency range to the cell.

The transmission from the portable cellular telephone is traditionally accomplished through an antenna. In one configuration of a cellular telephone, known as a car phone, the transmitting/receiving unit is fixed at a location in the car, usually the trunk. The antenna in this configuration is fixed to the exterior of the car to facilitate reception and transmission of electromagnetic wave signals. The car phone also has a hand set disposed at an accessible location for the user. Usually, the hand set is disposed in the passenger cabin and is mechanically and electrically linked to the antenna by a mechanical and electrical link with the transmitting/receiving unit of the car phone. Thus, in this configuration the user has minimal exposure to the electromagnetic waves generated by the car phone. The transmitting/receiving unit of the car phone, which may be a source of electromagnetic wave radiation exposure, is at a relatively safe distance from the user in the trunk. The antenna of the car phone, which transmits the electromagnetic wave radiation, is also at a relatively safe distance at a portion of the exterior of the car. Furthermore, the metal construction of the car acts to shield the user from the electromagnetic wave radiation.

In another configuration of a cellular phone, known as a transmobile phone, the transmitting/receiving unit is carried in a bag, and an antenna fixed to the transmitting/receiving unit transmits the electromagnetic wave radiation necessary for communication. Again, the hand set, which the user places against the head to hear and to speak, is disposed separate from the electromagnetic wave generating components of the cellular phone such as the transmitting/receiving unit and the antenna. Furthermore, when used within a car, a second antenna may be used which is disposed outside the vehicle to facilitate reception and transmission of the electromagnetic waves.

In a third configuration of a cellular phone, known as a hand-held cellular phone, the transmitting/receiving unit and antenna are provided in the interior and/or disposed on an outside surface of the handset. In other words, in the hand-held cellular phone, the transmitting/receiving unit, hand set (including a mouthpiece and an earpiece) and the antenna are provided in a single compact unit. This type of cellular phone has steadily increased in popularity because of the convenience and mobility afforded by its compact structure. Traditionally, these cellular phones transmit at a cellular frequency range between 800 and 900 megahertz and at a power any where from less than one to six or more watts.

When using the hand-held cellular phone, the user places the hand set to his head so that his ear is in contact with the earpiece, and his mouth is at a location close to the mouthpiece. The antenna, which usually extends from the top surface of the hand set, transmits and receives the electromagnetic wave radiation. It is also well known to provide an internal antenna within the hand set to make the hand-held cellular phone even more compact. The electromagnetic wave radiation transmitted by the antenna is generated by a transmitter disposed in the interior of the hand set. Therefore, the user is in close proximity to the source of transmission of electromagnetic wave radiation, and the head and brain of the user receives direct exposure of this electromagnetic wave radiation generated by the hand-held cellular phone.

It has been determined that the presence of the biological tissue (body, head and brain) alters the radiation pattern and reduces the antenna gain, and, that between 48 and 68% of the power delivered to the antenna of a hand-held cellular telephone is absorbed by the head and hand of the user (see, *EM Interaction of Handset Antennas and a Human in Personal Communications,* Proceedings of the IEEE, Vol. 83, No. 1, January 1995).

The power absorbed by the head and hand reduces the strength of the radiation signal emitted from the antenna for communication. In addition, by requiring the antenna to output a stronger signal, the power absorbed by the head and hand decreases the usable life of the battery of the cellular telephone.

Researchers are only now beginning to look into the potential link between cellular telephone use and detrimental biological effects, such as brain tumors. However, epidemiological studies have suggested that a link exists between exposure to power frequency electric and magnetic fields and certain types of cancer, primarily leukemia and brain cancer (see, *Questions and Answers About Electric and Magnetic Fields Associated With the Use of Electric Power,*

National Institute of Environmental Health Sciences, U.S. Department of Energy, November 1994).

Figure 7 shows a typical configuration for a hand-held cellular phone, commonly known as a "flip phone". This conventional cellular phone has a main phone body 1 having an earpiece 2 disposed thereon. A mouthpiece 3 shown in the closed position is flipped downward so that when the hand-held cellular phone is appropriately positioned by a user, the earpiece 2 is adjacent to the user's ear, while the mouthpiece 3 is adjacent to the user's mouth. An antenna 4, which may be telescoping or fixed, is disposed externally on the phone body 1. Alternatively or additionally, an antenna 4 may be internally disposed. The antenna 4 emits electromagnetic wave radiation to send communication signals from the hand-held cellular phone to a distant cell of a cellular network and receives electromagnetic radiation carrying communication signals from the cell. Thus, the user is able to communicate through the cellular network to the hard wire telephone network.

Antenna configurations include the familiar wand-like monopole, which extends from the top of the telephone, interior antennas, which are disposed within the telephone case, and flush mounted antennas, which are usually located on the sides, back or top of the telephone. Another type of antenna that can be used for transmitting and receiving cellular telephone signals is constructed by forming a metal patch on a dielectric substrate. This antenna configuration can be used as a flush mounted antenna. Examples of this type of antenna is disclosed in U.S. Patent No. 5,245,745, issued to Jensen et al., and U.S. Patent No. 5,241,321, issued to Tsao.

Each of these antenna configurations suffers from the problems of power being absorbed by the head and hand of the user. In particular, the flush mounted antennas suffer from a higher degree of electromagnetic interaction, since the head and hand are typically disposed very close to the antenna during use of the telephone. Also, the hand holding the telephone tends to mask the flush mounted antenna, causing a detuning effect on the antenna resonant frequency and impedance. This detuning can reduce the communication range of the telephone (see, *EM Interaction of Handset Antennas and a Human in Personal Communications*, Proceedings of the IEEE, Vol. 83, No. 1, January 1995).

As shown in Figure 8, internal radiation emanating components 5, and the external antenna 4 emit radiation which exposes the user to the health risks now being associated with exposure to electromagnetic wave radiation in the cellular frequency band. Furthermore, it is possible that the electromagnetic wave radiation emanating from the hand-held cellular phone or some other emanating radiation from the hand-held cellular phone is causing the recently observed health problems. However, at the present time the exact cause of the health risks is not known. But, it is apparent that there is great demand for a means to shield the users of hand-held cellular phones from unwanted, and possibly harmful, exposure to the radiation generated by the cellular phone. The extent of the danger seems to be as yet not known. In fact, there seems to be a deficiency in research on health effects of electromagnetic fields, particularly those emitted by portable phones in the cellular frequency band - 800 to 900 millions of cycles per second or megahertz. The cellular phone industry has done studies which target the thermal effects of electromagnetic fields. However, apart from thermal effects, recent tests have shown that radio waves around the cellular

frequency band can damage the resilient blood-brain barrier, which protects the brain from toxins. Furthermore, radio frequencies, including the European cellular frequency, have been shown to damage the calcium coating in cells that regulate the passage of hormonal "messages" between cells. Some scientists believe that the brain tissue absorbs some of the power of the electromagnetic radiation. In addition, higher frequency, higher power radiation signals are being looked at for satellite-based wireless communication systems. In these systems, a hand-held radio telephone will transmit and receive communication signals via satellites in earth orbit. The higher frequency radiation, possibly 1.6 gigahertz or higher, may pose even more of a risk to biological tissue, such as the body and brain of the user, due to the shorter wave length and higher transmission energy of the signal.

The exact empirical health risks which can be directly linked to the cellular phone are still not known. However, it is apparent that the users and future purchasers of cellular phones are demanding a means to protect themselves as much as possible from exposure to the radiation generated by the cellular phone.

Very recently, serious questions have arisen regarding the safety of users exposed to the cellular phone electromagnetic wave radiation. It has also been suggested that such exposure, particularly due to the use of a hand-held cellular phone, has contributed to the occurrence of cancer and brain tumors in the brains of users of cellular phones. It has recently been speculated that the electromagnetic wave radiation transmitted by the hand-held cellular phone has a detrimental effect on the blood-barrier when a user is exposed to electromagnetic wave radiation around the cellular frequency. It has been suggested further that the electromagnetic wave radiation generated by the cellular phone has a detrimental effect on calcium contained by body cells and disrupts the functioning of such cells. These serious concerns have prompted widespread consternation by users of cellular telephones. In fact, due to the concern over the effects of exposure to the electromagnetic wave radiation generated by the cellular phone, the future of the "wireless" communication industry has very recently been questioned.

Therefore, there is an urgent need in the cellular telephone art to provide a means for protecting users of cellular phones, particularly hand-held cellular phones, from unnecessary and possibly harmful exposure to the electromagnetic wave radiation generated by the cellular telephone. However, the conventional art merely provides electromagnetic wave shielding to protect internal circuitry from the noise influence of background radiation. There is no conventional device which is effective for protecting a user of cellular phones from unwanted exposure to electromagnetic wave radiation generated during use of the cellular phone.

SUMMARY OF THE INVENTION

The present invention is intended to overcome the drawbacks of the conventional art. It is an object of the present invention to provide a radiation shielding apparatus for a radio transmitting device which can shield a user from unwanted exposure to radiation emanating from a radiation emanating component of a radio transmitting device. It is another object of the present invention to provide a radiation shield for an antenna of a radio transmitting device, such as a hand-held cellular

telephone, for preventing unwanted exposure of a user of the hand-held cellular telephone to radiation emanating from a radiation emanating antenna, while allowing transmission of the emanating radiation so that the hand-held cellular telephone is effective for communication.

In accordance with the present invention, a radiation shielding apparatus for a radio transmitting device has shielding means disposed between a radiation emanating component and a user for preventing unwanted exposure of the user to emanating radiation from the radiation emanating component. The radiation emanating component may be an external antenna, or other electromagnetic radiation source, which may also be disposed in the interior of the radio transmitting device. The antenna may be either an internal antenna disposed in the interior of the radio transmitting device, or an external antenna, which is disposed on the exterior of the radio transmitting device.

The shielding means may be a radiation shield dimensioned to be retrofitted to an existing radio transmitting device. The shielding means may be effective to reflect electromagnetic radiation, block and/or absorb electromagnetic radiation.

The radio transmitting device may be a cellular phone radio, in particular a hand-held cellular phone. Alternatively, the radio transmitting device may be a radio transmitting computer modem, fax machine or the like. In the case of these devices, such as a hand-held cellular phone, a transmitter for transmitting electromagnetic radiation in a cellular frequency band may be included. The cellular frequency band is conventionally between 800 and 900 megahertz. The device, such as a hand-held cellular phone may have an internal or external antenna which transmits electromagnetic radiation in the cellular frequency band (or other electromagnetic frequency). Thus, the shielding means is effective to shield the user of the hand-held cellular phone from electromagnetic radiation emanating from either an external antenna, internal antenna, or other electromagnetic wave transmitter of, for example, a cellular phone.

In accordance with the present invention, a radiation shield is provided for an antenna of a radio transmitting device. Shielding means, disposed between a radiation emanating antenna and a user, prevents unwanted exposure of the user to emanating radiation from the radiation emanating antenna, while allowing transmission of the emanating transmission so that the cellular phone is effective for communication. The shielding means may be an elongated member disposable between the antenna and the user. The elongated member may be curved so as to wrap at least partially around a radius of radiation emanating from the antenna. Thus, the radiation emanating from the antenna toward the user is shielded from the user, and radiation emanating from the antenna not toward the user can be transmitted so that the cellular phone is effective for communication. The elongated member may be telescoping and have fixing means for fixing the elongated member at a position adjacent to the antenna. Thus, the inventive shielding means may be retrofitted to an existing cellular phone so that cellular phones already purchased can be made safe in view of the recently discovered potential health hazards due to exposure to electromagnetic wave radiation around the cellular frequency band. The elongated member may be an electromagnetic wave absorber, blocker and/or reflector. Furthermore, the shielding means may be one of an electromagnetic wave absorber, blocker, and/or reflector which is integrally disposed

on the antenna. In this case, the shielding means may be a coating, a material adhered to an antenna by an adhesive, or applied in other suitable fashion. Furthermore, antennas so equipped may be provided in the after-purchase market of the hand-held cellular phones so that existing cellular phones can be safely used, while shielding the user from unwanted exposure to electromagnetic or microwave radiation.

In accordance with another embodiment of the invention, the shielding means comprises a protective case. The protective case is made from a lamination comprising an outer durable cover and an inner shielding layer. The durable cover is preferably made of an aesthetically pleasing material, such as leather or vinyl, or can be formed from vacuum or injection molded plastic. The durable cover may alternatively be formed of a low density neoprene covered with a fabric (such as the material used in a scuba diver's wet suit). This construction provides a shock-absorbing protective case, and may be water tight to provide further protection to the cellular phone. The inner shielding layer is preferably made of a rip resistance material capable of preventing or attenuating passage of electromagnetic radiation (in the case of a cellular telephone, microwave radiation). An example of a material that may be used for the inner shielding layer is known as metalized mylar, which is a laminate of a metallic foil adhered to a sheet of mylar. Other materials can be used for the inner shielding layer, provided the appropriate reduction in the passage of electromagnetic radiation is obtained. To ensure consistent shielding characteristics, the shielding layer may be grounded to the ground of the cellular telephone. In accordance with this embodiment of the present invention, a features circuit is used for providing advantageous features, such as selectively increasing the volume of the sound emitted by the cellular phone speaker. The features circuit includes a microphone disposed facing the cellular phone speaker with the outer shell of the cellular telephone. An electric signal corresponding to the sound emitted by the cellular phone speaker is generated by the microphone and amplified by an amplifier. A battery supplies power to the features circuit. The amplified electric signal is received by an amplifying speaker, and the sound emitted by the cellular phone speaker is regenerated as an amplified sound by the amplifying speaker.

In accordance with another aspect of the present invention, a method of shielding an electronic circuit component is provided. The electronic circuit component may be, for example, the cellular telephone circuitry and/or antenna of a cellular telephone. A radiation shielding battery is disposed adjacent to the electronic component. To provide electrical shielding, the battery is comprised of at least one shielding material that is effective for electrically shielding electromagnetic radiation. The shielding material is preferably also a component of the energy storage contruction of the battery. The battery may be constructed of a negative planar electrode disposed at an electrically negative side of the battery. A positive planar electrode is disposed at an electrically positive side of the battery, and a plastic electrolyte is disposed between the negative planer electrode and the positive planar electrode. By this construction, a thin, flexible battery is provided that can be formed into an appropriate shielding shape, and may be part of the wall of the telephone case, thus maximizing space and weight considerations. At least one of the negative planar electrode and the positive planar electrode is a shielding material that shields electromagnetic

radiation. To further enhance the shielding effect, the electronic component may be grounded to the electrically negative side of the battery.

The battery may be formed into a hollow shape defining an electrically shielded interior space, and the electronic component may be disposed within the electrically shielded interior space. Thus, the battery effective shields the electronic component from electromagnetic radiation and provides a self-contained rechargeable power source.

In accordance with another aspect of the invention, an antenna assembly is provided for a radio transmitting device. A first unshielded antenna receives electromagnetic radiation from a remote source, and a seperate second shielded antenna emits electromagnetic radiation from the radio transmitting device. A radiation shielding apparatus is disposed during use of the radio transmitting device between the antenna and a user so as to be effective to shield the user from at least some of the electromagnetic radiation emanating from the antenna toward the user while allowing at least some of the electromagnetic radiation emanating from the antenna not toward the user to be transmitted, so that exposure of the user to potentially harmful radiation from the first antenna is prevented, while allowing the first antenna to transmit the electromagnetic radiation from the radio transmitting device. By this construction, the receiving antenna is shielded by the shielding apparatus only to a small extent, if at all. Thus, the receiving antenna is able to receive relatively weak radiation signals necessary for cellular telephone communication. The shielding apparatus shields the radiation emitted by the transmitting antenna toward the user, so as to prevent unwanted exposure of the user to radiation, but allows the radiation signal to be transmitted in directions away from the user.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a view showing a hand-held cellular phone having the inventive shielding means for shielding an electromagnetic radiation source disposed in the interior of the cellular phone and shielding means for shielding electromagnetic wave radiation from an external antenna disposed on the outside of the cellular phone;

Figure 2(a) is an illustration of an embodiment of the inventive radiation shielding apparatus shown shielding radiation emanating from an interiorly disposed radiation source in the body of the cellular phone and a radiation source disposed in the mouthpiece of the cellular phone;

Figure 2(b) is a view showing an embodiment of the inventive radiation shielding apparatus shown shielding an interiorly disposed radiation source of a cellular phone so that no unwanted radiation emanates from the radiation source;

Figure 3(a) shows an embodiment of the radiation shield for an antenna of a radio transmitting device comprised of an elongated member disposed adjacent to an external antenna of a cellular phone;

Figure 3(b) is a top plan view of the elongated member radiation shield shown in Figure 3(a) showing the elongated member having an open curve construction;

Figure 3(c) is a partial perspective view of a cellular phone showing an elongated member constructed as a sheath encompassing an external antenna of the cellular phone;

Figure 3(d) is a top plan view of the elongated member radiation shield shown in Figure 3(c);

Figure 4(a) is a partial perspective view of a cellular phone showing a telescoping elongated member disposed adjacent to an external antenna;

Figure 4(b) is a view of the telescoping elongated member having an antenna top clip attached to an external antenna of a cellular phone;

Figure 4(c) shows one embodiment of fixing means for attaching the inventive antenna shield to the antenna by an antenna base clip;

Figure 4(d) is an embodiment of fixing means of the inventive antenna shield for attaching the antenna shield to the cellular phone by a screw;

Figure 4(e) is an embodiment of fixing means of the inventive antenna shield having an clamp for fixing the antenna shield to an external antenna of a cellular phone;

Figure 4(f) is an embodiment of the fixing means of the inventive antenna shield showing the use of an adhesive for fixing the antenna shield to the hand-held cellular phone;

Figure 5 is a partial perspective view of a hand-held cellular phone having radiation shielding integrally disposed on an external antenna;

Figure 6(a) shows a construction of the radiation shield comprising a substrate supporting a radiation reflector;

Figure 6(b) shows a construction of the radiation shield comprising a substrate supporting a radiation absorber and/or blocker;

Figure 6(c) shows a construction of the radiation shield comprising a substrate supporting a radiation reflector and radiation absorber and/or blocker;

Figure 6(d) shows a construction of the radiation shield comprising a radiation reflector and radiation absorber and/or blocker;

Figure 6(e) shows a construction of the radiation shield comprising just a radiation reflector;

Figure 6(f) shows a construction of the radiation shield comprising just a radiation absorber and/or blocker;

Figure 7 shows the configuration of a conventional hand-held cellular phone;

Figure 8 shows the conventional hand-held cellular phone in use;

Figure 9 shows another embodiment of the radiation shield in use on a hand-held cellular telephone;

Figure 10(a) is a front view of the embodiment of the radiation shield shown in Figure 9 in a retracted, non-shielding position;

Figure 10(b) is a front view of the embodiment of the radiation shield shown in Figure 9 in a raised, shielding position;

Figure 11(a) is a front and side view of a radiation shield in accordance with the embodiment shown in Figure 9;

Figure 11(b) is a front and side view of a mounting piece in accordance with the embodiment shown in Figure 9;

Figure 11(c) is a top plan view of the radiation shield shown in Figure 11(a);

Figure 11(d) is a perspective view of the radiation shield and the mounting piece in accordance with the embodiment shown in Figure 9;

Figure 12(a) is a front view showing the embodiment of the radiation shield shown in Figure 9, and a radiation shielding antenna;

Figure 12(b) is a side view showing the embodiment of the radiation shield shown in Figure 9, and the radiation shielding antenna;

Figure 13 is a plan view of a prior art antenna assembly for a hand-held cellular phone;

Figure 14(a) is a side view and a top view of an internal antenna component of the prior art antenna assembly shown in Figure 13;

Figure 14(b) is an enlarged top plan view of the internal antenna component shown in Figure 14(a);

Figure 14(c) is an enlarged top plan view of an embodiment of an internal antenna component in accordance with the present invention;

Figure 14(d) is an enlarged top plan view of another embodiment of an internal antenna component in accordance with the present invention;

Figure 15(a) is a side and top view of a fixing member of the prior art antenna assembly shown in Figure 13;

Figure 15(b) is an enlarged top plan view of the fixing member shown in Figure 15(a);

Figure 15(c) is an enlarged top plan view of an embodiment of the fixing member in accordance with the present invention;

Figure 16(a) is an isolated view of an external antenna having a shielding strip in accordance with the present invention;

Figure 16(b) is an enlarged cross sectional view of the external antenna having a shielding strip shown in Figure 16(a);

Figure 16(c) is an enlarged cross sectional view of the external antenna shown in Figure 16(b) installed in the embodiment of the fixing member shown in Figure 15(c);

Figure 17 is a side view of a hand-held cellular telephone being shielded and protected by another embodiment of the invention comprised of a protective case shown in cross section;

Figure 18(a) is an enlarged cross section showing a laminate construction of the protective case shown in Figure 17;

Figure 18(b) is an enlarged cross section of the protective case having a features circuit in accordance with the embodiment shown in Figure 17;

Figure 19(a) is a top plan view of a splayed protective case pattern in accordance with the embodiment shown in Figure 17;

Figure 19(b) is an enlarged isolated view of a jack shown in Figure 19(a);

Figure 20(a) is a perspective view of a cellular telephone having the protective case;

Figure 20(b) is an isolated perspective view of the assembled protective case;

Figure 21(a) is a front view of the protective case installed on a cellular telephone;

Figure 21(b) is a side view of the protective case installed on a cellular telephone;

Figure 21(c) is a back view of the protective case installed on a cellular telephone;

Figure 22(a) is a side view of another embodiment of the protective case having a shielding flap and installed on a cellular telephone;

Figure 22(b) is a side view of the protective case having a shielding flap and installed on a cellular telephone in a flap shielding position;

Figure 23(a) is an isolated enlarged cross sectional view of a flexible rechargeable battery used in accordance with the present invention;

Figure 23(b) is an isolated schematic view of a cellular phone circuit board disposed adjacent to the flexible rechargeable battery;

Figure 24(a) is a cross sectional top view of a flexible rechargeable battery and phone case shell prior to assembly in accordance with a manufacturing aspect of the present invention;

Figure 24(b) is a cross section top view of the assembled flexible rechargeable battery and phone case shown in Figure 24(a);

Figure 24(c) is a cross sectional side view taken along line c-c of the assembled flexible rechargeable battery and phone case shown in Figure 24(b);

Figure 24(d) is an isolated enlarged cross sectional side view of an assembled and electrically sealed end of the phone case shown in Figure 24(c);

Figure 25(a) is a perspective view of an unassembled wrapped flexible rechargeable battery and electrically sealing endcaps;

Figure 25(b) is a perspective view of an assembled wrapped flexible rechargeable battery having electrically sealed ends and having wires in communication with the interior of the wrapped flexible rechargeable battery;

Figure 25(c) is a perspective view of an inventive cylindrical shaped cellular telephone;

Figure 25(d) is a cut away perspective view of an alternative construction of the wrapped flexible battery having an antenna window through-hole;

Figure 26(a) is a cross sectional side view of another embodiment of the inventive cellular telephone having the flexible rechargeable battery disposed for radiation shielding and having a retractable hand shield;

Figure 26(b) is a cross sectional back view taken along line b-b of Figure 26(a) of the inventive cellular telephone having the flexible rechargeable battery disposed for radiation shielding and having a retractable hand shield;

Figure 26(c) is an isolated and enlarged cross sectional side view of the antenna assembly shown in Figures 26(a) and 26(b);

Figure 27(a) is a schematic cross sectional view of another embodiment of an inventive cellular telephone having a closed retractable mouthpiece;

Figure 27(b) is a schematic cross sectional view of the embodiment of the inventive cellular telephone shown in Figure 27(a) having an open retractable mouthpiece;

Figure 28(a) is a block diagram of inventive electrical power supply and battery selection circuitry;

Figure 28(b) is a block diagram of inventive telephone mode selection circuitry;

Figure 29(a) is a side perspective view of another embodiment of the inventive cellular telephone having grip disposing surfaces;

Figure 29(b) is a back perspective view of the embodiment of the inventive cellular telephone shown in Figure 29(a);

Figure 29(c) is a front perspective view of the embodiment of the inventive cellular telephone shown in Figure 29(a);

Figure 30 is a perspective view of an embodiment of the inventive cellular telephone in use being gripped by a hand of a user;

Figure 31(a) is a perspective view of a home-base unit and external battery pack in accordance with an embodiment of the inventive cellular telephone;

Figure 31(b) is a perspective view of an embodiment of the inventive cellular telephone having an attached external battery pack;

Figure 31(c) is a perspective view of the embodiment of the inventive cellular telephone shown in Figure 31(b) having attached add-on function modules;

Figure 32 is a perspective view of a car-base unit and an embodiment of the inventive cellular telephone;

Figure 33 is a schematic view of radiation shielding components in accordance with an embodiment of the inventive cellular telephone;

Figure 34(a) is an exploded perspective view of an embodiment of a shielded radiation patch antenna assembly in accordance with the present invention;

Figure 34(b) is a perspective view of an assembled radiation patch antenna in accordance with the embodiment shown in Figure 34(a);

Figure 34(c) is a perspective view of an assembled shielded radiation patch antenna assembly in accordance with the embodiment shown in Figure 34(a);

Figure 35(a) is an exploded perspective view of another embodiment of a shielded radiation patch antenna assembly in accordance with the present invention;

Figure 35(b) is a perspective view of an assembled radiation patch antenna in accordance with the embodiment shown in Figure 35(a);

Figure 35(c) is a perspective view of an assembled shielded radiation patch antenna assembly in accordance with the embodiment shown in Figure 35(a);

Figure 36(a) is an exploded perspective view of another embodiment of a shielded radiation patch antenna assembly in accordance with the present invention;

Figure 36(b) is a perspective view of an assembled shielded radiation patch antenna assembly in accordance with the embodiment shown in Figure 36(a);

Figure 37 is an exploded perspective view of another embodiment of a shielded radiation patch antenna assembly in accordance with the present invention; and

Figure 38 is a side perspective view of another embodiment of the inventive cellular telephone having grip disposing surfaces and having a shielded radiation patch antenna assembly.

DETAILED DESCRIPTION OF THE DRAWINGS

For purposes of promoting an understanding of the principles of the invention, reference will now be made to the embodiments illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, there being contemplated such alterations and modifications of the illustrated device, and such further applications of the principles of the invention as disclosed herein, as would normally occur to one skilled in the art to which the invention pertains.

Referring to Figure 1, an embodiment of the inventive radiation shielding apparatus for a radio transmitting device is shown. In this case, the radio transmitting device comprises a hand-held cellular phone. However, the radio transmitting device may be any other radio transmitting system in which a source of potentially harmful electromagnetic radiation is disposed close to the body of the user. In this case, the exact configuration of the radiation shield may vary depending on what type of component is being shielded. However, such alterations are expressly within the scope of the present invention.

As shown in Figure 1, shielding means 10 is disposed between a radiation emanating component 12 (external antenna 12' and interiorly disposed electromagnetic radiation source 12) and a user to prevent unwanted exposure of the user to radiation emanating from the radiation emanating component 12. The antenna 12' may be an external antenna 12' disposed on the exterior of the radio transmitting device, or an internal antenna disposed in the interior of the radio transmitting device 14. The shielding means 10 may be a radiation shield 10' which is dimensioned to be retrofitted to an existing radio transmitting device 14. For example, to shield the user from electromagnetic radiation emanating from an interior radiation emanating component 12, such as a transmitter within an existing cellular phone without such shielding, a preformed sheet member (comprising an electromagnetic wave radiation reflector, blocker and/or absorber), may be disposable within the interior of the existing cellular phone at a position effective to shield emanating electromagnetic wave radiation from exposing the user. Alternatively, the radiation shield may be more generic and can be cut and bent into a shape so that it can be disposed within the interior of an existing cellular phone at a position where it is effective for its intended use. Although a cellular phone is shown, the radiation emanating component may be a part of a radio transmitting computer modem, fax transmission device, or other radio transmission device.

Shielding means 10 may be disposed within a hand-held cellular phone to prevent exposure of a user from radiation emanating from a transmitter within the phone. In the case of a typical cellular phone, the transmitter transmits radiation in a cellular frequency band conventionally between 800 and 900 megahertz. Therefore, the material comprising the shielding means 10 is composed of a material effective to block, absorb or reflect electromagnetic wave radiation within this band range. However, since other frequency ranges may be emitted by different radio transmitting devices, the appropriate type and dimensions of the material of the shielding means 10 should be selected accordingly.

Referring now to Figures 2(a) and 2(b), alternative configurations of the shielding means 10 is shown shielding interiorly disposed electromagnetic wave radiation sources of a hand-held cellular phone. These configurations represent two shielding states, one in which the interiorly

disposed electromagnetic radiation source 12 is partially shielded and the other in which the interiorly disposed electromagnetic radiation source 12 is fully shielded. As shown in Figure 2(a), the interiorly electromagnetic radiation source 12 which may by a transmitter within the body of the cellular phone, is shielded so that electromagnetic wave radiation traveling in a direction towards the user is blocked, absorbed or reflected. In this embodiment, the electromagnetic wave radiation may still be transmitted from the hand-held cellular phone so that communication with a distant cell of a cellular network is possible. This configuration can be used to shield an internal electromagnetic wave transmitter, such as an internal antenna disposed in the interior of a hand-held cellular phone radio transmitting device 14, in which case the external antenna may or may not be present. Also, as shown, if other portions contain electromagnetic wave radiation sources 12, such as in the mouthpiece 16, these components may be shielded to prevent unwanted exposure of the user. As shown in Figure 2(b), an interiorly disposed transmitter may be fully shielded so that no harmful electromagnetic wave radiation generated by such a transmitter can expose the user. In this case, an external antenna 12' disposed on the exterior of the hand-held cellular phone radio transmitting device 14 is typically used for transmission of electromagnetic wave radiation. In which case, the external antenna 12' has appropriate shielding for preventing exposure of the user to electromagnetic wave radiation as described herein.

Referring now to Figure 3(a) and 3(b), a radiation shield for an antenna 12' of a radio transmitting device 14 is shown. In this embodiment, shielding means 10 is disposed between a radiation emanating antenna 12' and a user for preventing unwanted exposure of the user to emanating radiation from the radiation emanating antenna 12' while allowing transmission of the emanating radiation so that communication between the hand-held cellular phone and a distant cell of a cellular network is possible. The radiation emanating antenna 12' comprises at least one of an internal antenna 12' disposed in the interior of the radio transmitting device 14 (represented by the interiorly disposed electromagnetic radiation sources, shown for example, in Figure 2) and an external antenna 12' disposed on the exterior of the hand-held cellular phone radio transmitting device 14 as shown in Figure 3. The antenna 12' transmits electromagnetic radiation in a cellular frequency band, typically between 800 and 900 megahertz. The shielding means 10 comprises an electromagnetic radiation reflector, blocker and/or absorber.

In the configuration shown in Figures 3(a) and 3(b), the shielding means 10 comprises an elongated member 10' which in use is disposed between the antenna 12' and the user. The elongated member 10' has an open curve construction so as to wrap partially around a radius of radiation emanating from the antenna 12' (shown in Figure 3(b)) so that radiation emanating from the antenna 12' toward the user is shielded from the user while radiation emanating from the antenna 12' not toward the user can be transmitted to allow communication between the hand-held cellular phone radio transmitting device 14 and a distant cell of a cellular network.

In the configuration shown in Figures 3(c) and 3(d), the shielding means 10 comprises an elongated member 10' disposable between the antenna 12' and the user. The elongated member 10' has a closed curve construction so as to sheath the antenna 12' and wrap completely around a radius of radiation emanating from the antenna 12' (shown in Figure 3(d)). The side of the

elongated member 10' closest to the user comprises a material which shields the user from radiation emanating from the antenna 12' toward the user. The other side of the elongated member 10' allows radiation emanating from the transmitter to pass so that communication is possible. This side may comprise a material which does not prevent transmission of the emanating radiation, or may have a construction, such as through-holes, which allows transmission. In the case of this side being metal, it may by in direct electrical contact with the antenna 12' so as to become a radiation emanating component 12. This configuration can be easily slipped over an existing cellular phone antenna and may be clipped, clamped or fastened to the antenna 12' at an orientation effective to shield the user from harmful exposure while allowing transmission of electromagnetic radiation necessary to allow communication.

As shown in Figures 4(a) and 4(b), the elongated member 10', used as a radiation shield for an antenna 12' may comprise at least two telescoping portions so as to be telescoping between an extended and a retracted position. This construction may also comprise a radiation shield elongated member 10' having different cross sectional configurations. For example, it may take the form of an open or closed boxed shape, open or closed curve, or a flat planar member. Fixing means shown in Figure 4(b) through 4(f) is provided for fixing the radiation shield to either the body of the hand-held cellular phone or to the antenna 12'. For example, as shown in Figure 4(b), an antenna top clip 18 extending from the top portion of the telescoping elongated member 10' radiation shield clips onto the top portion of a telescoping antenna 12'. The base of the radiation shield may have fixing means for attaching the base to the antenna 12' base and/or the body of the hand-held cellular phone. Thus, the telescoping radiation shield may be extended and retracted in conjunction with the telescoping antenna 12'. In the case of a fixed antenna 12', the radiation shield may be disposed so that it is also non-telescoping or still can be a telescoping member. Other construction of the shielding means 10 will lend to alternative constructions of the fixing means. For example, the shielding means may be configured as a sheath disposable over the antenna 12' and capable of blocking or reflecting radiation in a particular harmful frequency range, while allowing transmission of other radiation for communication.

As shown in Figure 4(c), the fixing means may comprise an antenna base clip 20 which clips onto the antenna 12' at the antenna base. A more permanent radiation shield fixing means is shown in Figure 4(d) in which the base of the radiation shield is fixed by a screw 22 screwed to the body of the hand-held cellular phone radio transmitting device 14. In Figure 4(e), the base of the radiation shield is clamped, the clamp represented by a box 24, to the base of the antenna 12'; and in Figure 4(f), the bottom surface of the base of the radiation shield is fixed to the body of the hand-held cellular phone radio transmitting device 14 by an adhesive 26. It is noted that these examples of the fixing means are in no way exhaustive, and many other configurations would be readily apparent to one of ordinary skill in the art.

Figure 5 shows another embodiment of the inventive radiation shield for an antenna 12'. In this embodiment, the shielding means 10 comprises at least one of an electromagnetic wave absorber, reflector and/or blocker which is integrally disposed on the antenna 12'. As shown, the shielding means 10 may comprise a radiation shielding coating applied to a portion, for example

along the longitudinal length, of the antenna 12' to one side thereof. Thus, a portion of the antenna 12' is still effective for transmitting electromagnetic wave radiation to a distant cell of a cellular network. However, electromagnetic wave radiation directed toward the user is effectively blocked to thereby prevent possible harmful effects of such exposure to electromagnetic wave radiation. It is noted that many existing hand-held cellular phone radio transmitting devices 14 are provided with detachable antennas, and as such, the inventive radiation shield integrally disposed on a retro-fittable antenna 12' may be provided so that the existing hand-held cellular phone radio transmitting device 14 is still usable by merely switching antennas. In the case of a radiation blocking shielding coating, a material such as lead can be applied and integrally fixed to the antenna.

Figures 6(a) through 6(f) show various configurations for the inventive shielding means 10. As shown in Figure 6(a), the shielding means 10 may comprise a substrate 28, such as metal, polymer, fiberglass or other suitable material, having a radiation reflector 30, such as aluminum, other metal, polymer or other suitable material disposed thereon. As shown in Figure 6(b), the substrate 28 may have a radiation absorber and/or blocker 32, such as lead, or other suitable material disposed thereon. As shown in Figure 6(c), the substrate 28 may have both a radiation reflector 30, a radiation absorber and/or a radiation blocker 32(or other combination) disposed thereon. As shown in Figure 6(d), the shielding means 10 may comprise a radiation reflector 30 and a radiation absorber and/or radiation blocker 32 formed together in a self supporting structure. As shown in Figure 6(e), the shielding means 10 may simply be a radiation reflector 30 comprised of a material capable of being self supporting. Similarly, as shown in Figure 6(f), the shielding means 10 may comprise a radiation absorber and/or blocker 32 which is also self supporting thereby obviating the need for an additional substrate 28. The shielding material can be formed on the antenna in a variety of processes. For example, a shielding material can be spray coated at appropriate portions of an antenna. Alternatively, the shielding material can be formed by sputtering, vacuum deposition, dip coating, or any other suitable process. The shielding means 10 can be made to block the electromagnetic radiation emanating from the electromagnetic source, such as the antenna 12', and toward the user. For example, a material which presents a relatively dense block to the passage of electromagnetic radiation, such as lead, can be used.

The shielding means 10 can be made to reflect the electromagnetic radiation emanating from the electromagnetic source, such as the antenna, and toward the user. For example, a polished material, such as aluminum, provides high reflectance. The elongated member 10' may be shaped to optimize the advantages of directing the reflected electromagnetic waves. For example, a parabolic shape with a highly reflective surface, will direct the waves to a focus (as shown, for example, in Figure 25(c).

On the other hand, it may be advantageous to reflect the waves at diffusing angles so that they spread out and reflect off of nearby surfaces so as to provide a more non-uniformity of the transmission direction. This is advantageous since the cell may be in a direction from the antenna in line with the user's head. In this case, the shielding means 10 might attenuate transmission of electromagnetic waves if the waves are directed and focused in the opposite direction. However,

by diffusing (or scattering) the direction of the electromagnetic radiation, communication with such a cell may be improved.

The shielding means 10 can be made to absorb the electromagnetic radiation so that radiation emanating towards the user is absorbed and does not expose the user to the potential harmful effects of the electromagnetic radiation.

Further, a combination of one or more layers of reflecting, absorbing and blocking material can be used to provide an optimum radiation field. In any case, the material selected can be such that the radiation exposure of the user is minimized by selecting appropriate materials to "tune" to the anticipated radiation frequency range.

Referring to Figure 9, an embodiment of the inventive radiation shielding apparatus is shown retrofitted on an existing cellular telephone 14. In this case, the radio transmitting device comprises a hand-held cellular phone 14. However, the radio transmitting device 14 may be any other radio transmitting system in which a source of potentially harmful electromagnetic radiation (in the case of a cellular telephone, microwave radiation) is disposed close to the body of the user. In this case, the exact configuration of the radiation shield may vary depending on what type of component is being shielded. However, such alterations are expressly within the scope of the present invention.

As shown in Figure 9, shielding means 10 is disposed between a radiation emanating component 12 (internal antenna 12' and/or external antenna 12') and a user to prevent unwanted exposure of the user to radiation emanating from the radiation emanating component 12. The shielding means 10 may be configured to be retrofitted as a replacement antenna assembly including an internal antenna 12' and an external antenna 12'.

Shielding means 10 may be disposed within a hand-held cellular phone to prevent exposure of a user from radiation emanating from a transmitter within the phone. In the case of a typical cellular phone, the transmitter transmits radiation in a cellular frequency band conventionally between 800 and 900 megahertz. Since other frequency ranges may be emitted by different radio transmitting devices, the appropriate type and dimensions of the material of the shielding means 10 should be selected accordingly.

Figures 9-16(c) show a specific embodiment of the inventive shielding means 10 and inventive antenna radiation shield 10' retrofitted to a Motorola Digital Personal Communicator™ cellular telephone. Referring to Figure 10(a), the shielding means 10 is shown in a non-shielding position. This non-shielding position provides no attenuation of an incoming signal from a cell of a cellular network. The external antenna 12' is shown retracted. In this position, the user may have the phone in the "stand-by" mode and tucked away in a brief case or coat pocket. In such a case, it would not be desirable for the shielding means to attenuate the incoming signal from a cell. However, when a call is received (or when the user wishes to place a call) the external antenna 12' is extended. To shield the user from exposure to the radiation emanating from the internal antenna, the shielding means 10 may be raised into the shielding position, as shown in Figures 9 and 10(b). In this position, the shielding means 10 reflects radiation emanating from the internal antenna 12'

toward the user in directions away from the user. Since the radiation is reflected, it is still available for transmission to the cell so that there is little or no attenuation of the transmission signal.

Figures 11(a)-11(d) show an embodiment of the inventive radiation shielding device which can be easily and inexpensively produced. This configuration is designed specifically for hand-held cellular phones such as the Motorola Digital Personal Communicator™. However, various other configurations can be readily designed to fit any specific application. The configuration consists of a shield member 10 having a front face 34 with a slot 36 disposed therein. The shield member 10 may have a gripping edge 38 to facilitate positioning of the shield member 10 as described below. The shield member 10 has a suitable bend (such as 90 degrees) to form a side 40. In accordance with this embodiment, the front face 34 and side 40 shield the user's head from radiation emanating from the internal antenna 12' when the shield member 10 is in the raised position (Figures 9 and 10(b)). The front face 34 and the side 40 may have a flat profile, or as shown in Figure 11(c), either or both of them may be curved.

As shown in Figure 11(b), a mounting piece 42 has posts 50 extending from its front surface. The back surface of the mounting piece 42 is covered with a pressure sensitive adhesive 52 for adhering the mounting piece 42 at an appropriate location on the cellular phone 14 to position the shielding means 10 for its intended use (as shown in Figures 9 and 10(b)).

Figure 11(d) shows perspective views of the shield member 10 and mounting piece 42. When assembled, the posts 50 pass through the slot 36 and the shield member 10 is retained on the mounting piece via the retaining ends 54 of the posts 50. This assembly is permanently or semi-permanently fixed on the cellular phone 14 by the pressure sensitive adhesive 52.

In use, when the shielding means 10 is to be positioned for shielding, the user grasps the gripping edge 38 and slides the shield member 10 into position. Bumps (not shown) on the slot 36 may be provided to temporarily lock the shield member 10 in the up or down position. In this configuration, the user has the option of lowering the shield member 10 if the signal is too weak and if the raised shield is between a distant communicating cell of the cellular network and the phone 14. Raising the shield member 10 reflects the radiation and may increase the signal sent and received by a distant communicating cell that is in a direction away from the user's head.

This embodiment of the invention can be very easily and very inexpensively manufactured. The shield member 10 is simple to form by die-cutting and bending a thin metal sheet. To increase the effectiveness of the shielding means 10, a grounding wire (not shown) may be providing for grounding the shielding means 10 with the ground of the cellular telephone 14. The mounting piece 42 is readily adaptable to an injection molding process. Also, a shield member substrate can be formed by injection molding, and made from a material with a color and texture that matches or compliments the existing cellular phone body. This injection molded shield member substrate may then have a radiation blocker, absorber and/or reflector material disposed on its peripheral surface. The peripheral surfaces may be sensitized and then electroplated, and may be spray coated or vacuum deposited with an appropriate material.

Figures 12(a) and 12(b) are front and side views, respectively of a hand-held cellular phone 14, such as the Motorola Digital Personal Communicator™. The hand-held cellular phone

14 is shown retrofitted with the shielding means 10 consisting of a shielding member 10 as described above, and antenna shielding means 10' consisting of a shielding strip 56 disposed on a replacement extendible external antenna 12'. The shielding strip 56 blocks radiation from emanating from the wire coil disposed within the external antenna 12' toward the user. However, radiation emanating in a direction not toward the user is not shielded. It is noted that either the shielding member 10 or the shielding strip 56 may be used separately, depending on a determined potential exposure concern. The dimensions and material of the shield member 10 and shielding strip 56 depends on a determined balance between radiation shielding and signal attenuation.

Figure 13 shows an exploded view of a prior art antenna assembly for use with a hand-held cellular phone 14, such as the Motorola Digital Personal Communicator™. This assembly includes the external antenna 12' which has a wire coil (not shown) disposed within a plastic substrate. A fixing member 58 screws in place in a threaded hole on the cellular phone 14 to secure the antenna assembly on the cellular phone 14. The internal antenna 12' plugs into the cellular phone transmission/reception circuitry and provides most or all of the emanating radiation when the external antenna 12' is in the retracted position. A cap 60 snaps in place on the cellular phone 14 and forms a part of the assembled cellular phone body structure.

Figure 14(a) shows a respective side and top plan view of the internal antenna 12' in accordance with the prior art. Figure 14(b) shows an enlarged top plan view of the prior art internal antenna 12'. Figure 14(c) shows an internal antenna 12' in accordance with the invention having a radiation shielding structure 10'. A foil radiation shielding structure 10' is fixed on the surface of the inventive internal antenna 12' at a position designed to block exposure of radiation directed at the user. Figure 14(d) shows a configuration of the inventive internal antenna 12' with a metal radiation shielding member 10' having a shielding effect to a broad range of radiation. The shielding member 10' may include one or a combination of a radiation absorber, radiation reflector and/or radiation blocker.

Referring now to Figure 15(a) a respective side and top plan view of the prior art fixing member 58 is shown. Figure 15(b) shows an enlarged top plan view of the prior art fixing member 58. The prior art fixing member 58 has a hollow cylindrical shape having a circular profile through which the prior art external antenna 12' passes and is free to rotate about its longitudinal axis. When assembled on the hand-held cellular telephone 14, the prior art internal antenna 12' passes over the fixing member 58. Figure 15(c) shows a configuration of the fixing member 58 in accordance with the present invention and has in top plan view a semicircular profile forming an orientation retaining surface 58' which acts with a similar profile of the inventive external antenna 12' (shown in Figures 16(a)-16(c)) to maintain an effective orientation by preventing rotation of the external antenna 12'.

Figure 16(a) shows an embodiment of the inventive external antenna 12' which has the shielding strip 56 (shown by cross-hatch) disposed along its length. The width of the shielding strip 56 determines the degree and direction of the shielding effect. Figure 16(b) shows a top plan cross sectional view taken at line a-a of Figure 16(a). The inventive external antenna 12' has a semi-circular profile similar to the semi-circular profile of the inventive fixing member 58. As

shown in Figure 16(c), when the inventive external antenna 12' is assembled with the fixing member 58, the semi-circular profiles maintain the external antenna 12' at a desired orientation. This orientation disposes the shielding strip 56 to provide shielding of the user from emanating radiation while allowing transmission of electromagnetic wave radiation (shown by fanned lines) for cellular communication.

Figure 17 shows a side view of a cellular telephone 14 shielded by another embodiment of the inventive shielding means 10, shown in cross section. In accordance with this embodiment of the invention, the shielding means 10 comprises a protective case 62. The protective case 62 is made from a lamination comprising an outer durable cover 64 and an inner shielding layer 66 (shown in enlarged isolated cross section in Figure 18(a)). The durable cover 64 is preferably made of an aesthetically pleasing material, such as leather or vinyl, or can be formed from vacuum or injection molded plastic. The durable cover 64 may alternatively be formed of a low density neoprene covered with a fabric (such as the material used in a scuba diver's wet suit). This construction provides a shock-absorbing protective case 62, and may be water tight to provide further protection to the cellular phone 14. The inner shielding layer 66 is preferably made of a rip resistant material capable of preventing or attenuating passage of electromagnetic radiation. An example of a material that may be used for the inner shielding layer is known as metalized mylar, which is a laminate of a metallic foil adhered to a sheet of mylar. Other materials can be used for the inner shielding layer, provided the appropriate reduction in the passage of electromagnetic radiation is obtained. In accordance with this embodiment of the present invention, an additional advantageous feature is the inclusion of a features circuit 68 that is used for providing advantageous features, such as selectively increasing the volume of the sound emitted by the cellular phone speaker 70 (shown in enlarged isolated cross section in Figure 18(b)). The features circuit 68 includes a microphone 72 disposed facing the cellular phone speaker 70 with the outer shell 14' of the cellular telephone 14. An electric signal corresponding to the sound emitted by the cellular phone speaker 70 is generated by the microphone 72 and amplified by an amplifier 74. A battery 76 supplies power to the features circuit 68. The amplified electric signal is received by an amplifying speaker 78, and the sound emitted by the cellular phone speaker 70 is regenerated as an amplified sound by the amplifying speaker 78.

Figure 19(a) shows a splayed protective case pattern 80 from which is formed the folded protective case 62 shown in Figure 20(b). The splayed protective case pattern 80 is folded into the shape shown in Figures 20(a) and 20(b) for fitting onto and protecting a hand-held cellular phone 14. Although a specific splayed protective case pattern 80 is shown for protecting a specific cellular phone body type, other patterns can be used having a particular shape corresponding to the particular shape of the cellular phone intended to be protected and shielded. The splayed protective case pattern 80 shown in Figure 19(a) has Velcro hook patches 82 and corresponding Velcro loop patches 84 which maintain the shape of the folded protective case 62 as shown in Figures 20(a) and 20(b). Windows 86 are provided for allowing access to buttons 88 and viewing of a display screen 90 of the protected and shielded cellular phone 14, as shown in Figure 20(a). A flap portion 92 is provided for covering the top and a portion of the back of the cellular phone 14, and

includes a through-hole 94 for accommodating the antenna 12' and cap 60 of the cellular phone 14. A tail portion 96 may be provided that slips into a gap provided by a hinged portion of the cellular telephone 14 located between the mouthpiece 16 and the main phone body (as shown in Figures 21(a) through 21(c)). The tail portion 96 includes a jack 98 which is received in a jack receiver 100 of the cellular telephone 14 (shown in Figure 21(a)-21(c)). Again, this embodiment is being described with reference to a specific configuration applicable to a specific cellular telephone body style (namely, the Motorola Digital Personal Communicator™). Other configurations of the protective case 62 will have a different shape. The jack 98 includes an electrical contact 102 for connection with the ground of the cellular telephone 14 for grounding the shielding layer 66. By thus grounding the shielding layer 66 the shielding aspects of the inventive shielding means 10 is greatly enhanced, as compared with an ungrounded shielding layer 66. Alternatively, other means may be incorporated for connecting the shielding layer 66 with the ground of the cellular telephone 14 and still be encompassed by the scope of the invention. Figure 19(b) shows an enlarged view of the jack 98. In addition to the ground electrical contact 102, other electrical contacts 102 can be provided. The other electrical contacts 102 can be utilized to provide such things as power or signals to the features circuit 68 for providing additional advantageous features, such as a call timer, digital message recorder, or other features depending on the outputs of the jack receiver 100.

As shown in Figures 20(a) and 20(b), when installed on a cellular telephone 14, the protective case 62 is positioned so that the through-holes 94 are facing the phone speaker 70, and the windows 86 allow access to the buttons 88 and viewing of the display screen 90. The tail portion 96 is slipped into a gap provided by a hinged portion of the cellular telephone 14 located between the mouthpiece 16 and the main phone body. The tail portion may terminate in the jack 98, or may terminate in a Velcro covered end for engaging with a Velcro patch disposed on the back surface of the protective case 62. As an alternative to Velcro, other fastening devices can be used, such as snaps, zippers, laces, etc. The cellular phone 14 is held within the protective case 62, and the durable cover 64 is effective for preventing damage to the cellular phone 14 due to it being dropped or otherwise abused, while the shielding layer 66 is effective for preventing harmful exposure of the user to the radiation emitted by the cellular phone 14.

Figures 21(a) through 21(c) show the various components of the features circuit 68 in position on a hand-held cellular phone 14. The positional relationships, sizes and number of components is illustrated by way of example only, the actual attributes of the features circuit 68 will depend on the desired features and the phone body type. The microphone 72 and amplifying speaker 78 are preferably disposed adjacent to and facing the phone speaker 70. The microphone 72 and/or the amplifying speaker 78 may be piezoelectric elements, so as to reduce the overall thickness of the installed protective case 62. Also, although shown covering substantially the entire cellular telephone 14, the protective case may have a reduced size, and if only the feature circuitry 68 is desired, may be provided lacking the shielding layer 66. The feature circuitry 68 includes at least one of the means for amplifying the phone speaker 70 (microphone 72, amplifier 76 and amplifying speaker 78); a power source (battery 76 or a power line tapping off of the phone

battery), a call timer 104, a recorder 106, a call screener 108, an external speaker jack 110, an external microphone jack 112, a modem/fax port 114, or other advantageous circuitry. The call timer 104 is provided to enable the user to determine the length of time spent on a current phone call and/or the time remaining before extending into the next billing unit. Usually, a billing unit consists of a minute of connect time. For example, most cellular telephone services charge their clients for each minute or portion of a minute used to make a cellular phone call. The cost per minute or per portion of a minute used to make a cellular telephone call is fairly expensive. To make the most economical use of the time charged for a cellular phone call, the call should terminate just before the end of a billing unit, and before the call extends into the next billing unit. The call timer 104 provides the advantageous feature of warning the user when the end of a billing unit is coming up. For example, the call timer 104 can produce an audible signal at the end of every 50 seconds of each minute billing unit, thus warning the user that if the call is not terminated within 10 seconds, another billing unit will be charged. The call timer 104 can be manually activated by pressing a button 116 at the onset of a cellular phone call, or may be activated by a switch (not shown) that is turned on each time the mouthpiece 16 is flipped open (in which case, the call timer 104 is only accurate when a call is received and answered by flipping open the mouthpiece 16). For a more accurate determination of the connect time, the call timer 104 may be activated by a signal received from the cellular telephone 14 each time a billable connection with the cellular phone network is made. The signal may be received through a wire (not shown) connected with an electrical contact 102 included on the jack 98 and connected with an appropriate output of the cellular telephone 14. A resettable memory unit (not shown) can also be provided to keep track of and display accumulated billable connect time.

The recorder 106 is used to record the sound emitted from the phone speaker 70. The recorder 106 can provide many useful features, such as answering machine capabilities for sending a user-recorded outgoing message and recording a caller-recorded message. The recorder 106 can also be used for recording information received during a phone call. For example, directions, phone numbers, or other messages given by the caller during a phone conversation with the user can be recorded by the recorder 106. The recorder 106 is activated manually by the user by pressing a record button 118 and the recorded information is played back by pressing a play button 120. Answering machine circuitry 122 can be provided, linked to the cellular phone through the jack 98, for outputting a recorded outgoing message upon the reception of a call, and after playing the outgoing message, recording a caller-recorded message for later playback by the user. The answering machine circuitry 122 can incorporate similar circuitry as that utilized in a conventional answering machine. The recorder 106 can include a nonvolatile memory integrated circuit capable of storing analog signals, such as an EEPROM capable of storing analog data written directly into a single cell without A/D or D/A conversion. This storage method results in an increase in storage density as compared with equivalent digital storage methods, and allows non-volatile storage of analog data. An example of an EEPROM capable of storing analog data is the ISD1000A family of storage devices manufactured by Information Storage Devices, Inc. of San Jose, California, and sold under the trademark DAST™. The advantages of the DAST™ storage device for use in the

recorder 106 include obviating the conventionally required magnetic tape, and corresponding drive motor and circuitry, allowing for a great reduction in size and making the recorder suitable for use with a small hand-held cellular phone. The DAST™ storage device, and its equivalents, require very few parts for use as a single chip voice message system. The sound amplifying components of the invention, the microphone 72, amplifying speaker 78 and battery 76, along with a few switches, resistors and capacitors, are all that is required to provide a complete voice record and playback system. Functions, such as pre-amplification, filtering, AGC, power amplification, logic control and analog storage are all performed on the single chip. To further reduce the overall size of the inventive protective case 62, the capabilities of the single chip may be used when providing other inventive features, such as sound amplification of the sound emitted by the phone speaker 70. Stated otherwise, particular capabilities of the single chip, namely, pre-amplification, filtering, AGC, power amplification and/or logic control, can be used for the voice record and playback system, as well as for the sound amplification system, external speaker, modem/fax port. etc. The recorder 106 may, alternatively, utilize conventional recording tapes (such as the commonly used micro-cassette tape) and recording devices, if minimizing the size of the device is not a major consideration.

The call screener 108 receives a caller phone number signal when an incoming call is received by the cellular telephone. The call screener 108 converts the caller phone number signal to a displayed value so that the user can determine from what phone number the incoming call is being sent. If the cellular phone 14 has appropriate capabilities (either by modification or by stock design) the call screener 108 can input the caller phone number through the jack 98 to be received by the cellular phone 14 by the jack receiver 100 for display of the caller phone number on the cellular telephone display. Alternatively, a separate LCD display (not shown) can be provided on the inventive protective case 62.

The external speaker jack 110 is provided for allowing a connection between the amplified sound emitted from the phone speaker 70 and an external speaker; or between the cellular telephone internal speaker wiring and an external speaker using a connection between the jack receiver 100 and the jack 98. The external microphone jack 112 is provided for allowing a connection between an external microphone and the cellular telephone 14 using a connection between the jack receiver 100 and the jack 98.

The modem/fax port 114 allows connection with a fax machine or a computer for the transmission of data through the wireless connection between the cellular telephone 14 and the cellular phone network. For data reception, the sound emitted from the phone speaker 70 can be received by the modem/fax port 114. If data transmission is desired, then a connection with the mouthpiece 16 or the internal microphone wiring of the cellular telephone 14 is provided (not shown) so that sounds emitted by the modem/fax port can be sent over the wireless cellular phone network from the cellular telephone 14.

As shown in Figure 21(b), the cellular telephone 14 has a battery 103. Different sized batteries 103 may be used with the cellular telephone 14 depending on the charge time desired, whereas a larger sized battery 103 is used when an extended usable charge time is desired, while a

small sized battery 103 is used when the overall size of the cellular telephone 14 is to be minimized. In order to accommodate different sized batteries 103, the protective case 62 may include elastic fabric portions 101.

Figures 22(a) and 22(b) show another embodiment of the inventive protective case 62 installed on a cellular telephone 14. The flap portion 92 shown, for example, in Figure 19(a) is elongated to form a shielding flap 124. When the external antenna 12' of the cellular telephone 14 is retracted, the shielding flap 124 is fixed to the back of the protective case 62. When the external antenna 12' is raise, the shielding flap 124 is placed in a shielding position in front of the external antenna 12' to prevent radiation emanating from the antenna 12' from reaching the user.

Figure 23(a) is an isolated enlarged cross sectional view of a flexible rechargeable battery 126 used in accordance with the present invention. The flexible rechargeable battery 126 is used, in accordance with the present invention, as a radiation shielding battery 126 that includes at least one shielding material that is effective for electrically shielding electromagnetic radiation. The radiation shielding battery 126 is preferably a rechargeable plastic lithium-ion battery, such as that produced by Bellcore, of Livingston, NJ. Such a battery has an unfolded thickness that is about the same as the thickness of a creditcard. The battery 126 comprises a plastic member 128, which is formed by impregnating a plastic with a liquid electrolyte. The resulting plastic electrolyte member 128 is typically about 50% liquid and cannot leak. The plastic electrolyte member 128 is sandwiched between a positive plastic electrode 130 melded to an aluminum mesh 132 and a negative plastic electrode 134 melded to a copper mesh 136. Thus, in accordance with the present invention, the radiation shielding battery 126 comprises a negative planar electrode side (negative plastic electrode 134 and copper mesh 136) disposed at an electrically negative side of the battery 126, a positive planar electrode side (positive plastic electrode 130 and aluminum mesh 132) disposed at an electrically positive side of the battery 126, and an electrolyte member 128 disposed between the negative planer electrode side and the positive planar electrode side. At least one of the negative planar electrode side and the positive planar electrode side is comprised of the shielding material for electrically shielding electromagnetic, or microwave, radiation. In accordance with the preferred embodiment of the invention, the negative planer electrode side comprises the shielding material. Preferably, an electronic component 138 that is to be shielded is grounded to the negative planer electrode side through an appropriate electrical connection, such as a ground wire 140 electrically connected between a connecting land 142 of the battery 126 and a connecting land 142 of the electrical component 138. To provide additional electromagnetic shielding, a radiation absorbing layer 144 may be disposed as a laminate component of the radiation shielding battery 126, as shown in Figure 23(a). Also, a radiation blocking layer and/or reflecting layer (not shown) may be included in addition to, or substituted for, the radiation absorbing layer 144. The radiation blocking, reflecting and/or absorbing layer may include a magnetic shielding material, such as Mu metal, to enhance the prophylactic features of the invention.

Figure 23(b) is an isolated schematic view of a cellular phone circuit board (electronic component 138) disposed adjacent to the flexible rechargeable battery 126. The radiation

absorbing layer 144 (and/or radiation blocking layer, radiation reflecting layer) may be disposed as a separate structure adjacent to a folded radiation shielding battery 126, which may or may not include a laminate component radiation absorbing layer 144. In accordance with the present invention, as shown in Figure 23(b), the radiation shielding battery 126 comprises a thin laminar structure that can be cut, shaped and folded into appropriate dimensions to fit within a case shell of the cellular telephone. By this construction, the radiation shielding battery 126 functions both as a radiation shielding member and as a rechargeable electrical power source. The obtainable voltage from the radiation shielding battery 126 can be adjusted by electrically connecting two or more similarly constructed batteries.

Figures 23(a) and 23(b) illustrate an inventive method of shielding an electronic circuit component 138. In accordance with the inventive method, an electronic component 138 is provided, such as the circuit components, internal antennae, keyboard, speaker, microphone, etc. of a cellular telephone. A radiation shielding battery 126 is disposed adjacent to the electronic component 138. The battery 126 is comprised of at least one shielding material (such as the copper mesh 136 of the negative planer electrode side) which is effective for electronically shielding electromagnetic radiation. As shown, the battery comprises a negative planer electrode disposed at an electrically negative side of the battery. A positive planer electrode is disposed at an electrically positive side of the battery, and an electrolyte member 128 is disposed between the negative planer electrode and the positive planer electrode. Preferably, at least one of the negative planer electrode and the positive planer electrode comprises a material which is effective to act as the shielding material for shielding electrode magnetic radiation. Thus, by this construction, an electromagnetic shield is provided for shielding the electronic component 138 of the cellular telephone from incoming electromagnetic wave radiation (to reduce circuit noise), and for shielding electromagnetic wave radiation emanating from the electronic component 138 (to prevent exposure of the user from electromagnetic radiation generated by the components of the cellular telephone). Preferably, as shown in Figure 23(b), the electronic component 138 is electrically grounded to the electrically negative side of the radiation shielding battery 126. A circuit ground wire 140 may be soldered or otherwise fixed to the electronic component 138 (circuit board) and the copper mesh 136 of the radiation shielding battery 126.

Figure 24(a) is a cut away perspective top view of a flexible rechargeable battery 126 and a case shell substrate 146 prior to assembly in accordance with a manufacturing aspect of the inventive method for shielding an electronic component 138. The flexible rechargeable battery 126 preferably has the structure described above with reference to Figures 23(a) and 23(b). The flexible rechargeable battery 126 is preferably fixed to a case shell substrate 146 using an adhesive 148. The adhesive 148 may have radiation shielding, reflecting or blocking properties, and may be comprised of, for example, fine Ferro-magnetic particles dispersed within a rubber or epoxy adhesive medium. Prior to assembly, the flexible rechargeable battery 126 and the case shell substrate 146 are substantially flat sheet-like members, and thus can be easily shipped from a place of manufacture to a distant place of assembly. The case shell substrate 146 has notches 150 which facilitate folding of the case shell substrate 146. Two of the edges of the case shell substrate 146

terminate in toothed engaging structures 152 which, as shown in Figure 24(b) mate together and become engaged to retain the case shell substrate 146 and the rechargeable battery 126 in a folded position. By this structure, a cellular telephone case member can be easily formed simply by folding the rechargeable battery 126 and case shell substrate 146 and engaging the toothed engaging structures 152. In accordance with the present invention, the cellular telephone case member is very easy and inexpensive to manufacture, while providing both electromagnetic shielding and a rechargeable battery.

Figure 24(b) shows a cross-section top view of the inventive cellular telephone case member formed from the assembled flexible rechargeable battery 126 and case shell substrate 146 shown in Figure 24(a). As shown, once the flexible rechargeable battery 126 and case shell substrate 146 are folded, and the toothed engaging structures 152 are mated, a electrically shielded interior space 154 is defined within the formed cellular telephone case member. The electrically shielded interior space 154 is electromagnetic shielded to prevent radiation emanating from internally disposed electronic components 138 from reaching the user of the cellular telephone, and also preventing external electromagnetic radiation from reaching the electrically shielded interior space 154 of the cellular telephone case member to prevent the unwanted introduction of circuit noise.

Figure 24(c) is a cross-sectional side view taken along line c-c of the assembled flexible rechargeable battery 126 and case shell substrate 146 shown in Figure 24(b). In Figure 24(c), the flexible rechargeable battery 126 has more folds, and thus is shown having more layers than are shown in Figures 24(a) and 24(b). The number of layers, and thus the length of the unfolded, unassembled flexible rechargeable battery 126 will depend on factors such as desired battery life, shielding capabilities, weight, and required interior space 154 of the assembled case shell substrate 146 member. In accordance with the inventive method for shielding an electronic circuit component, the rechargeable battery 126 is formed into a hollow shape defining an electrically shielded interior space 154. An electronic component 138 (cellular phone circuitry) is disposed within the electrically shielded interior space 154. The interior space 154 defined by the battery is opened at its ends, and thus preferably these ends should be electrically shielded to prevent electromagnetic radiation from entering the electrically shielded interior space 154 and from exiting from the electrically shielded interior space 154. A shielding cap member 156 is fixed to the folded flexible battery to electronically close the open ends. The shielding cap members 156 may be fixed to the folded flexible battery 126 using either or both of a conductive adhesive 148 and a conductive tape (shown in Figure 26(b)).

In accordance with the present invention, the circuit components of a cellular telephone may be disposed within a electrically sealed folded flexible rechargeable battery 126 and electrically connected with the battery 126 to enhance the shielding aspects, and to provide a rechargeable power source for the phone circuitry. Appropriate electrode leads 160 may be provided from the cellular phone circuitry, through the shielding cap member 156 and electronically connected with a jack 162 so that the electronic phone circuitry 138 shielded within the electrically shielded interior space 154 can be connected with components disposed outside of the electrically shielded interior

space 154. In this case, the radiation shielding battery 126 may be formed and sealed to create a hollow electrically shielded interior space 154 that is electrically sealed to prevent electromagnetic radiation in the form of external noise from effecting the cellular phone circuitry 138, while preventing electromagnetic radiation generated by the cellular phone circuitry 138 from exiting the electrically shielded interior space 154 to thereby protect the user of the cellular phone. The thus formed flexible rechargeable battery 126 containing within a sealed electrically shielded interior space 154 the cellular phone circuitry 138 may simply be inserted within a cellular case shell substrate 146 which includes the other necessary components for cellular phone communication. In this case, the folded flexible rechargeable battery 126 and the cellular phone circuitry 138 disposed within the electrically shielded interior space 154 comprise an easy to install modular unit which can be plugged into the cellular phone (not shown) and electrically connected via the jack 162. By this construction, an easy to carry, compact unit is provided which includes a self-contained rechargeable power supply. The cellular phone circuitry 138 is shielded against electronic noise, and is shielded from emitting harmful radiation and/or electronic noise. The self-contained unit may include circuitry 138 containing personal data, such as a phone number, speed-dial numbers, voice recognition, call log, modem, fax, etc., and may be easily transported by the user and inserted in a variety of devices. For example, rental car companies may provide a cellular telephone system which includes all of the necessary hardware except for that contained within the self-contained unit. A user then merely has to insert the personalized self-contained unit into the cellular phone hardware supplied with the rental car, to instantly obtain a customized cellular telephone communication device.

Figure 24(d) is an isolated enlarged cross-sectional view of an assembled and electrically sealed end of the case shell substrate 146 shown in Figure 24(c). The shielding cap member 156 is adhered to and fixed with the folded flexible rechargeable battery 126 through the use of an electrically conductive seal, such as an electrically conductive adhesive 148 or an electrically conductive tape. As shown, an electrically conductive adhesive 148 is used to completely seal off the electrically shielded interior space 154 so that electromagnetic radiation cannot enter or escape from the electrically shielded interior space 154. Also, the adhesive 148 or tape may comprise appropriate material, such as silicone, epoxy, etc. to provide a water type seal thus waterproofing the electrically shielded interior space 154. By this construction, a completely waterproof cellular telephone may be easily provided, as will be described in more detail below. In accordance with the present invention, the cellular telephone case member can be easily formed by fixing the flexible rechargeable battery 126 to the case shell substrate 146 so that the case member has at least a portion of at least one wall comprised of the case shell substrate 146 and the battery 126. By this construction, the overall size of the phone may be greatly reduced, since the interior portion of the cellular phone includes a rechargeable power source that also functions as a shielding device. Thus, an external power pack, which is conventionally required, may be obviated. Also, the case shell substrate 146 may comprise a thin and flexible material, as opposed to the conventionally required thicker and usually brittle material, since the case member includes both the structural integrity of the case shell substrate 146 and the structural integrity of the flexible rechargeable

battery 126. Therefore, in accordance with the present invention, a cellular phone may be designed having excellent electromagnetic shielding capabilities to prevent unwanted noise and to prevent harmful exposure of the user to electromagnetic radiation, while having a substantially reduced size and more durable construction as compared with the conventional art. Also, in accordance with the radiation shielding battery construction described above with reference to Figure 23(a), through-holes may be easily formed in the battery to electrically connect the electronic components 138 disposed within the electrically shielded interior space 154 with exteriorly disposed components (i.e., external battery pack, antenna, microphone, speaker, keyboard, etc.). Thus, in accordance with the present invention, a through-hole may be formed in the radiation shielding battery 126, and a conductive wire 164 may be passed through the through-hole and electrically connected with the electronic circuit component 138 (as shown in Figure 25(b)).

Figures 25(a) through 25(c) show an alternative method of manufacturing an electronically shielded electronic device such as a cellular telephone. As shown, a case is provided for electronically shielding an electronic device. The case includes a case shell substrate 146, which as shown, may define a hollow tubular shape. The case shell substrate 146 may be easily formed by an injection molding process, or other suitable forming method. A radiation shielding battery 126, such as that shown, for example in Figure 23(a), includes at least one shielding material that is effective for electrically shielding electromagnetic radiation. The radiation shielding battery 126 is rolled into a hollow tubular shape so as to define an electrically shielded interior space 154. An electronic component 128 is disposed within the electrically shielded interior space 154. A pair of shielding cap members 156 are fixed to the rolled radiation shielding battery 126. The shielding cap members 156 include a shape-maintaining cylindrical extension 166 which fits snugly within the inside diameter of the rolled radiation shielding battery 126. When installed on the rolled battery 126, the battery 126 is maintained between the outside peripheral surface of the shape-maintaining cylindrical extension 166 and the inner peripheral surface of an outer cylindrical portion 168 of the shielding cap member 156. As shown in Figure 23(a), at least one of the shielding cap members 156 may include a jack 162 having electrical terminals that can be electrically connected with the electronic circuit disposed within the electrically shielded interior space 154 and the positive and/or negative electrode sides of the radiation shielding battery 126. This jack 162 may then be utilized for electrical communication between the battery, the circuitry 138 disposed within the electrically shielded interior space 154, and externally disposed circuitry, such as a speaker, microphone, keyboard, antenna, etc. of a cellular phone unit.

Figure 25(b) is a perspective view of an assembled rolled flexible rechargeable battery 126 having electrically sealed ends. The electrically sealed ends are formed by installing the shielding cap members 156 as described above, and then wrapping a conductive sealing tape 170 so that each shielding cap member 156 is fixed to and electrically sealed with the rolled radiation shielding battery 126. In addition to, or instead of the jack 162, through-holes may be formed in the rolled radiation shielding battery 126 and wires 164, such as a speaker wire, a mike wire, and a keyboard wire may be passed through the through-holes for electrical communication with the circuitry 138

disposed within the electrically shielded interior space 154. The through-holes may be electrically sealed using an appropriate sealant 172, such as a silicone, rubber or epoxy sealant containing Ferro-magnetic particles.

Figure 25(c) is a perspective view of an assembled inventive cylindrical shaped cellular telephone. In accordance with this embodiment, the electrically sealed radiation shielding battery 126 containing the electronic circuitry 138 may be easily installed within the tubular shaped shell case 146. The shell case 146 has mounted within it a keyboard, microphone, speaker, and antenna.

Figure 25(d) is a cut-away perspective view of an alternative construction of the rolled flexible battery 126. In accordance with this embodiment, the rolled flexible battery includes an antenna window through-hole 174 which may be cut, punched, or drilled into the flexible radiation shielding battery 126. In accordance with the construction of the radiation shielding battery 126 described with reference to Figure 23(a), the forming of an antenna window through-hole 174 will have only an minimal affect on the battery performance. The antenna window through-hole 174 is disposed at the side of the inventive cellular telephone that points away from the user. The battery 126 provides electromagnetic shielding of the user from the radiation emitted from the antenna 180 of the inventive cellular telephone, while the antenna window through-hole 174 allows electromagnetic radiation emitted from the antenna to pass through the antenna window through-hole for communication purposes. Thus, in accordance with this aspect of the invention, a cellular telephone antenna 180, which may be mounted on the cellular telephone circuit board, is disposed within an electrically shielded interior space 154 defined by the wrapped tubular radiation shielding battery 126. The antenna 180 is positioned within the electrically shielded interior space 154 so that it is adjacent to the antenna window through-hole 174. During use of the inventive cellular telephone, the radiation shielding battery 126 is disposed between the user and the antenna 180, thus protecting the user of the inventive cellular telephone from the harmful effects of the emitted radiation, while allowing for the effective transmission of a radiation signal by the antenna 180 for communication purposes.

Figure 26(a) is a view of another embodiment of the inventive cellular telephone having the flexible rechargeable battery 126 disposed for radiation shielding. In accordance with this embodiment, the flexible rechargeable battery 126 is folded in such a way that it is effective to electrically shield the various circuit components 128 of the cellular telephone, and to electrically shield a transmitting antenna. The flexible rechargeable radiation shielding battery 126 may have the structure described with reference to Figure 23(a). As shown, the flexible rechargeable battery 126 is folded so as to form an electrically shielded interior space 154 within which is disposed the various circuit components of the cellular telephone. Also, an antenna assembly space 176 is defined by the folded flexible rechargeable battery 126 within which is disposed an antenna assembly 178 including a transmitting antenna 180 for cellular phone communication. The antenna assembly space preferably is positioned so that the transmitting antenna 180 is disposed at the back of the inventive cellular telephone, with a large amount of the folded rechargeable battery 126 disposed between the transmitting antenna 180 and the user of the cellular telephone during

use of the phone to optimize the prophylactic shielding effect of the folded rechargeable battery 126. The antenna assembly space 176 thus allows electromagnetic radiation signals to be transmitted by the transmitting antenna 180 only in directions away from the user, thereby preventing harmful exposure of the user to the emitted electromagnetic wave radiation. As shown in dashed lines and solid lines, a retractable hand shield 182 may be disposed at the back of the inventive cellular telephone. The retractable hand shield 182 is pivotably fixed to the phone case member and can be disposed in a raised position (solid lines) to provide an additional shield for preventing exposure of the hand of the user to electromagnetic wave radiation emitted by the transmitting antenna 180. The retractable hand shield 182 may be pivoted against the cellular telephone body when not in use (dashed lines). The retractable hand shield 182 may be comprised of a radiation blocker, radiation absorber, and/or radiation reflector, and may have a component which is electrically grounded with the circuit ground of the inventive cellular telephone to enhance the prophylactic effect of the hand shield 182. To further enhance the electrical shielding effect, a sealing cap member 156 may be installed to the flexible battery 126 and the case substrate 146 in a similar manner as described above with reference to Figures 24(c) and 24(d). The sealing cap members described herein may be comprised of an electrically conductive layer disposed on a supporting plastic substrate. The electrically conductive layer enables the electromagnetic wave shielding effect, while the supporting plastic substrate provides strength and integrity to the cellular telephone case member.

Figure 26(b) is a cross-sectional back view taken along line b-b of Figure 26(a) of the inventive cellular telephone. As shown, an additional electronic shield member (which may be another a flexible rechargeable battery 126) is disposed perpendicular to and adjacent with the folded flexible rechargeable battery 126 shown in cross-section in Figure 26(a). This additional shielding member is preferably adhered to and fixed with the folded rechargeable flexible battery through the use of a conductive adhesive 148 or conductive tape (not shown) so as to define an electrically shielded interior space 154 having an efficient shielding characteristic. The configuration and number of flexible rechargeable batteries 126 depends on the folding pattern, required voltage, shielding capabilities and storage requirements of the battery system. The flexible battery described with reference to Figure 23(a) provides exceptional design flexibility. Also shown are a pair of back-up battery 184 which may be provided for allowing emergency use of the cellular telephone. In accordance with this aspect of the invention, the back-up battery 184 provide a long shelf life electrical power supply, such as alkaline batteries. These alkaline back-up battery 184 are usable at any time, so that, for example, if the rechargeable batteries associated with the inventive cellular telephone become discharged at an inopportune time, the back-up battery 184 may be tapped to provide continuous usage of the cellular telephone.

Figure 26(c) is an enlarged and isolated cross-sectional side view of the transmitting antenna assembly 178 shown in Figures 26(a) and 26(b). In accordance with this aspect of the invention, a transmitting antenna 180 is disposed adjacent to an electromagnetic shielding system comprised of a radiation absorber, a radiation reflector, and/or a radiation blocker. As shown, a grounded electromagnetic shield 186 is provided fixed with a radiation absorber 188. The

grounded electromagnetic shield 186 is in electrical communication through a ground wire 140 with the circuit ground of the inventive cellular telephone. The radiation absorber 188 is provided to enhance the radiation shielding effect and to prevent unwanted exposure of the user to the radiation emitted by the transmitting antenna 180. The radiation absorber 188 and electromagnetic shield 186 are disposed between the transmitting antenna 180 and the user during use of the inventive cellular telephone. Thus, the user is adequately and effectively shielded from the harmful effects of the electromagnetic radiation emitted from the transmitting antenna 180, while still allowing the electromagnetic wave signal to be transmitted from the transmitting antenna 180 for effective communication. Also shown in Figures 26(a) and 26(b) is a separate receiving antenna 190 which is disposed within the telephone case member of the inventive cellular telephone so as to allow reception of a received electromagnetic radiation signal from a remote site, such as a terrestrial-based cell site, or a satellite transmitter in earth orbit. The receiving antenna 190 is preferably not shielded, since the radiation signal that it receives may be relatively weak. The receiving antenna 190 does not emit radiation, and therefore does not pose a potential radiation hazard to the user of the cellular telephone. Thus, in accordance with this aspect of the invention, two antennas are provided; one which is shielded and which transmits electromagnetic radiation, and another which is not shielded and which receives electromagnetic wave radiation.

Figures 27(a) and 27(b) show a schematic cross-sectional view of another embodiment of the inventive cellular telephone. In accordance with this embodiment, a retractable mouthpiece 192 is provided. The retractable mouthpiece 192 is housed in a closed position within the body of the inventive cellular telephone. To extend the mouthpiece to an open position, a hinged door 193 is opened allowing the retractable mouthpiece 192 to extend from its position within the cellular phone housing while being urged by a spring member 196. A coil spring 198 disposed at a pivot point of the retractable mouthpiece swings the retractable mouthpiece into position for communication. The retractable mouthpiece 192 preferably includes a microphone (not shown) which is effective for providing an electrical signal corresponding to the voice of the cellular phone user to the circuit board of the inventive cellular telephone. Also, as shown, a pair of back-up batteries 184 are provided for emergency use of the cellular telephone. The back-up battery 184 may be comprised of disposable alkaline batteries which have a long storage shelf life. Alternatively, slow-to-recharge but long storage life rechargeable batteries may be used as the back-up battery 184. A shielded transmitting antenna 180 is provided for transmission of an electromagnetic wave radiation signal, while an unshielded receiving antenna 190 is provided for reception of a radiation signal received from a remote transmitter, such as a terrestrial-based cell site, or a satellite transmitter in earth orbit. As an alternative, or in addition, to the radiation shielding battery 126 shown above, a shield member 195 may be provided comprised of a radiation absorber, radiation blocker, and/or radiation reflector, and may extend around the circuit board and circuit components of the cellular telephone. In the case of a radiation absorber, a rubberized material embedded with graphite or Ferro-magnetic particles may be utilized for absorbing electromagnetic wave radiation to thereby prevent harmful exposure of the user to the

radiation emitted by the components of the cellular telephone, while shielding the circuit components of the cellular telephone from the effects of outside introduced electromagnetic noise.

Figure 28(a) shows electrical power supply and battery selection circuitry. As described above with reference to Figures 26(a) through 26(c), and 27(a) and 27(b), in accordance with one aspect of the present invention a supplemental or back-up battery 184 may be used to provide emergency battery power so that the inventive cellular telephone is available for communication at times where it otherwise may not be. In accordance with an embodiment of the inventive cellular telephone, an internal battery 126 is provided which comprises a rechargeable flexible battery 126 that acts as a radiation shield (see Figures 23(a) through 26(b)). An external battery 194 may be included as described below (see, for example, Figures 31(b)). The external battery 194 and the internal battery 126 preferably comprise rechargeable battery units, such as a lithium or nickel-cadmium battery typically used in portable electronic devices. The internal battery 126 of the inventive cellular telephone may thus be supplemented with either or both of an external battery 194 and a disposal back-up battery 184. The user can choose between different modes of operation. In an auto switching mode, the telephone circuitry 200 is automatically supplied with power first from the external battery 194 (if present), and then, when a charge sensor 196 detects depletion of the external battery 194, a switch 198 automatically draws power from the internal battery 126. When the charge sensor 196 detects that the internal battery 126 is depleted, the switch draws charge from the disposable battery. This hierarchy uses the added external battery 194 first, since it can easily be replaced with another freshly charged external battery 194. The internal battery 126 is then used when the external battery 194 has been depleted. The internal battery 126 is less easy to be recharged than the external battery 194, since the phone is placed out of commission while it is placed in the charger to charge its internal battery 126. As a last resort, the back-up battery 184 can be used to provide emergency cellular phone communication. The disposable or back-up battery may be a conventional alkaline battery, or may be a rechargeable battery that is slow to charge but capable of holding its charge for long periods (as opposed to the internal battery 126 and external battery 194, which typically are quicker to recharge but have a relatively short storage shelf-life). A voltage conditioner 202 may be utilized to step up or step down the voltage and/or current obtained from the internal, external, or supplemental battery systems, so that the appropriate voltage and current is applied to the telephone circuitry 200. The user can utilize a battery mode selector 204 to manually select which battery to draw the power from for operating the telephone circuitry 200. Thus, if the external battery 194 and internal battery 126 are depleted, the user may select to utilize the back-up battery 184 for keeping the cellular phone in standby mode for both sending and receiving calls. In another selected mode, the back-up battery 184 is only used for sending calls, and thus will not be consumed while waiting for a call to be received. Thus, in accordance with this aspect of the present invention, an electrical power supply for an electronic device, such as a cellular telephone is provided. An internal battery 126 is provided for powering the electronic device. The internal battery 126 is disposed within the case member which contains the electronic device. An external battery 194 is provided which is connectable with the case member for powering the electronic device, and a back-up battery 184 is

disposable within the case member for powering the electronic device. Switching means are provided for switching a connection between the electronic device and the internal battery 126, the external battery 194, and the back-up battery 184 so that the electronic device is powered at different times by the different batteries. Controlling means (charge sensor 196 and switch 198) may be provided for determining an existence and a state of charge of at least one of the internal battery, the external battery 194, and the back-up battery 184, and for controlling the switching between the batteries and the telephone circuitry 200 depending on the determined existence and state of charge of the internal battery 126, external battery 194, and back-up battery 184. The switching means may be controlled so that if it is determined that an external battery 194 exists, then the electronic device is first powered by the external battery 194 until a state of charge of the external battery 194 reaches a predetermined limit. The electronic device is then powered by the internal battery until a state of charge of the internal battery 126 reaches a predetermined limit, and then the electronic device is powered by the back-up battery 184. Preferably, the internal battery comprises a radiation shielding battery 126 having the configuration and dimensions as described herein, so as to be effective in shielding the user from the potential harmful radiation emitted by the telephone circuitry 200 and antenna 180, preventing unwanted electromagnetic noise from effecting the performance of the telephone circuitry 200, and providing a power source.

Figure 28(b) is a block diagram of an inventive telephone mode selection circuitry. In accordance with this aspect of the invention, a cellular telephone is provided having cordless telephone circuitry 206, shared telephone circuitry 208, and cellular telephone circuitry 210. The cordless telephone circuitry 206 includes the circuitry components necessary for enabling the inventive phone to act as a cordless telephone. This type of telephone is particularly useful within the general location of a home-base unit provided at the home or office. The cellular telephone circuitry 210 includes the circuitry components necessary for the phone to act as a cellular telephone, allowing it to be taken with the user for use at remote distances from the home-base site. The shared telephone circuitry 208 includes all the circuitry components which are in common with the cordless telephone and cellular modes of operation. Thus, redundant circuit components are not necessary, and the inventive cellular telephone can act as a cordless telephone when appropriate and automatically switch to a cellular telephone when appropriate. A telephone mode selector 212 is provided which automatically detects when the user is within range of the cordless telephone home-base through a "handshake" signal. In this case, since the cost of a conventional telephone call is typically less than the cost of a cellular telephone call, it is preferred that the inventive telephone be used with the home-base as a cordless phone. A selector 213 receives a signal from the telephone mode selector and automatically selects the cordless telephone circuitry 206 when within range of the home-base unit. When the phone is not within range of the home-base unit (i.e., no "handshake" signal is received by the phone from the home-base unit within a predetermined interval), the selector 213 switches to the cellular telephone circuitry 210. If a transmitted call signal from the phone is received by the home-base, a home-base "handshake" signal is sent to the phone and the cordless phone circuitry 206 is used. If a "handshake" signal from the home-base is not received, then the cellular phone circuitry 210 is used to make the call.

The selection of cellular or cordless phone circuitry can be manually overridden for times when the phone is out of range of the home-base, so that the determination of which kind of phone circuitry to utilize can be obviated, and a cellular phone call is automatically made.

Figures 29(a) through 29(c) show a configuration of an inventive cellular telephone which promotes the correct placement of the hand of the user so that exposure of the hand to the radiation emitted by a radiation transmitting antenna 180 is reduced or avoided. In accordance with this aspect of the invention, the transmitting antenna 180 is shielded as described above. Also, a second receiving antenna 190 is provided which is not shielded so as to be effective for receiving the signals transmitted from a remote cell site or satellite. A grip disposing surface 214 is provided on the body of the cellular phone at locations that encourage the user of the cellular phone to position his hand within an area of safety that is shielded from the electromagnetic wave radiation emanating from the transmitting antenna 180. Figure 29(a) is a side perspective view of this embodiment of the cellular telephone having grip disposing surfaces 214. Figure 29(b) is a back perspective view, and Figure 29(c) is a front perspective view of this embodiment of the inventive cellular telephone. During use of the inventive cellular telephone, the hand gripping the cellular telephone is presented with a relatively softer, easier to grip surface located in the region covered by the grip-disposing surfaces 214. Preferably, the grip-disposing surfaces 214 occupy a region located at the sides and back, from the bottom of the cellular telephone to a location above the midpoint of the longitudinal axis of the cellular telephone. The front and the top region of the sides and back of the cellular telephone do not have the grip-disposing surfaces 214, but rather, preferably comprise a relatively harder, smooth surface texture, which is less likely to be gripped by the user's hand. Further, the user can be instructed to grip the phone only at the grip-disposing surfaces 214 in order to place his hand out of the way of the potential harmful radiation emitted by the transmitting antenna 180. A hook button 216 is provided at a convenient location at either of the sides of the cellular phone. The hook button 216 is used to answer an incoming call, or to hang-up after a call has been completed. Preferably, the display and keypad 217 are disposed at the back of the phone so that any radiation leakage or emission caused by the necessity for these components (due to, for example, electrical connection with the circuit components 138) is directed away from the user.

Figure 30 is a perspective view of the inventive cellular telephone shown in Figures 29(a) through 29(c), shown in use being gripped by a hand and disposed adjacent to the head of the user. As shown, the grip-disposing surfaces 214 present a tactile surface that is easily distinguished by the hand, so that the user grips the phone appropriately. The transmitting antenna 180 is disposed within a shielded antenna assembly space which allows effective transmission of the emitted electromagnetic wave radiation signal in directions that are away from the user, while preventing the harmful exposure of the head and body (i.e., hand) of the user to emitted radiation when the cellular telephone is in use. The receiving antenna 190 is shown disposed at the back and top of the inventive cellular telephone, within an area that is not purposefully shielded. Thus, the receiving antenna 190 is effective for receiving the transmitted electromagnetic wave radiation signal being sent by a remote cell site or satellite. The location and configuration of the receiving

antenna 190 and the transmitting antenna 180 is shown for illustrative purposes only, although it is preferable that the transmitting antenna 180 be disposed at a location which promotes the effective shielding of the transmitted electromagnetic radiation to prevent it from impinging on and possibly harming the body, hands, and head of the user. The type of antenna used may be a quarter wave antenna, monopole antenna, dielectric antenna, etc. and is effective for transmitting the electromagnetic wave radiation signal that is used for communication with the inventive phone or other electronic device.

Figure 31(a) is a perspective view of a home-base unit 218 and external battery 194 in accordance with an embodiment of the inventive cellular telephone. As shown, the home-base unit 218 includes an electrical power supply plug 220 which plugs into the standard wall socket of conventional home electrical wiring. A telephone jack 222 plug is provided for electrically connecting the home-base unit 218 with the telephone system of the home. A reception/transmission antenna 224 is provided for receiving a signal from the inventive cellular telephone, and transmitting a signal to the inventive cellular telephone. The signal received and transmitted constitutes the phone communication carried through the home telephone system. As shown in Figure 31(a), an external battery 194 may be charged by placing the battery pack within a receiving well, in a conventional charging manner. As shown in Figure 31(b), the external battery 194 may be attached to the inventive cellular telephone. Alternatively, the inventive cellular telephone may include the internal flexible rechargeable battery 126 described above with reference to Figure 23(a), and thus the external battery 194 may be obviated, or provided to extend the useful time available for communication with the cellular telephone. The external battery 194 and internal flexible rechargeable battery 126 may be depleted in the manner described above with reference to, for example, Figure 28(b). Also, a back-up battery system as described above may be included within the inventive cellular telephone.

As shown in Figure 31(c), one or more add-on modules 226 may be attached to the cellular telephone. The stackable add-on modules 226 allow the user to customize and enhance the cellular telephone features. Also, the stackable add-on modules 226 allow the inventive cellular telephone to be updated so that, for example, an analog cellular telephone may be converted to a digital cellular telephone by attaching the appropriate stackable add-on module, which is in turn electrically connected with appropriate circuitry 138 of the inventive cellular telephone. Also, the stackable add-on modules 226 may provide the features of a digital recorder, a voice-recognition system, a call screener, call timer, the supplemental back-up battery 184, the rechargeable external battery 194, a fax/modem, a pager, a computer down-loadable address book, a computer down-loadable call log (for client billing, checking phone usage, etc.), or other stackable add-on modules 226 which may be developed through the course of further refinements to the inventive cellular telephone system.

Figure 32 shows a car-based unit 228 and the embodiment of the inventive cellular telephone shown in Figures 29(a) through 29(c). The car-base unit 228 is mountable within an automobile to enable battery charging and enhanced use of the inventive cellular phone. The internal rechargeable battery 126 is recharged by placing the cellular telephone within the receiving

well of the car home-base unit 228. The car-base unit 228 includes a stereo speaker wire harness 230 which electrically connects with the stereo speaker wire harness provided with the stereo system of an automobile. Thus, the speakers of the automobile used for the radio, cassette, or CD player may also be utilized for telephonic communication utilizing the inventive cellular telephone. Furthermore, the stereo speaker wire harness 230 may include an appropriate construction that allows one or more of the speakers of the car stereo system to act as an external microphone for cellular communication. For example, during a phone conversation, the driver's side front speaker may be utilized as a microphone, while the rest of the car's speakers are utilized as the telephone speakers for the inventive cellular telephone. By this construction, the inventive cellular telephone may be disposed in the receiving well of the car-base unit 228, and if a call comes in while the driver is driving, an appropriate switching signal is provided to by-pass the stereo sound signals generated by the stereo of the automobile, and utilize the speakers of the car for cellular phone communication. The stereo speaker wire harness 230 may include switching means receptive of the switching signal and effective for switching a connection with the speakers between the home-base unit 228 and the stereo system of the car. The front driver's side speaker acts as a receiving microphone, while the rest of the speakers of the automobile perform as speakers for the cellular telephone. Thus, an easy to install hands-free cellular phone system is provided in accordance with this aspect of the invention. A car cigarette lighter adapter 232 is provided for supplying electrical power to the car-base unit 228. The car-base unit 228 may include a microphone 234 and an external speaker 236 disposed within it for communication via the cellular telephone. An external antenna connector 238 may also be provided for connecting with an externally disposed antenna, which may be placed at the outside surface of the car. An alternate antenna 240 may be provided on the car-base unit 228, which is capable of emitting a stronger signal than the transmitting antenna 180 of the hand-held cellular telephone. The relatively stronger signal emitted by the car-home-base will be more effective for cellular phone communication, but since it is located at a remote distance from the driver, it will not present a potential radiation hazard. The output of the alternate antenna 240 should not however be so great as to pose any potential health risks. The car-base unit 228 emits a "handshake" signal that is different from the "handshake" signal emitted by the home-base unit 218. Thus, the cellular phone can determine the base unit type (cellular or cordless), utilizing the circuitry described above with reference to Figure 28(b). The car-base unit 228 (and/or the home-base unit 218) may emit a digital "handshake" which can be programmed in the cellular phone. Thus, different cellular phones can be added to the communication signal by programming in the cellular phone the "handshake" of the car-base unit 228 and the home-base unit 218. The "handshake" insures that call transmission is only receivable between phones and home bases programmed for a particular system.

Figure 33 is a schematic view of radiation shielding components in accordance with the inventive cellular telephone. The shielding and sealing means described with reference to, for example, Figures 24(a) through 24(d) and 23(a) through 25(d), allow for the manufacture of a waterproof and electromagnetically shielded cellular phone. A circuit board and antenna assembly is appropriately shielded utilizing the inventive electromagnetic wave shielding mechanism

described herein. The microphone and speaker of the cellular telephone are constructed with a waterproof metalized mylar diaphragm 242, as opposed to the conventionally used paper diaphragm. The metalized mylar diaphragms shield the user against radiation emitted by a magnetic field coil 244 that is connected with a circuit wire 246 for electrical communication with the telephone circuitry 138. Alternatively, or in addition, an absorber 248 may be disposed adjacent to the magnetic field coil of the speaker and microphone. Thus, the user is protected against electromagnetic wave radiation that is conducted through the circuit wire 246. The circuit board 138 of the cellular telephone is encased in a radiation shield 250, which may include a radiation absorber, reflector and/or blocker, and which may be a radiation shielding battery 126 as described above. The antenna assembly 178, including a transmitting antenna 180, is disposed adjacent to a radiation shield 250, which may include a radiation absorber, reflector and/or blocker, and which may be a radiation shielding battery 126 as described above. A reflecting layer 252 may be provided along a wall of the radiation shield 150 facing the antenna assembly space 176. Preferably, the reflecting layer 252 is disposed at a distance of l/4 from the radiation absorber 188 of the antenna assembly 178, wherein l is equal to the wave length of the radiation signal emitted from the transmitting antenna 180. By this construction, at least some of the radiation that leaks past the radiation absorber 188 is reflected by the reflecting layer 252 as a cancellation wave back toward the radiation absorber 188. As shown, the keypad and display 217 may be disposed at the back of the cellular telephone so that the radiation shield is disposed between the user, and the keypad and display. By this construction, the user is protected from any potential harmful radiation that may be emitted from the keypad and display 217 due to the electrical connection of these components with the radiation generating components of the telephone circuitry 138.

Figures 34(a) through 38 show embodiments of the present invention which provide a shielded radiation patch antenna assembly 254. In accordance with this aspect of the present invention, a patch antenna 256 is used as a communication signal transmitter for the cellular telephone. The patch antenna 256 may also be used as a signal receiver, or, a separate unshielded receiving antenna 190 (having any appropriate antenna construction) may be used. In accordance with the present invention, the radiation emitting patch antenna 256 is effectively shielded to prevent the unwanted and potentially harmful exposure of the user to the emitted radiation, while allowing for transmission of an emitted radiation signal in directions away from the user.

A thin-film patch antenna 256 is formed by coating or lamination both sides of a dielectric substrate 258 with a thin film of metal. The metal can be formed on the dielectric substrate 258 by sputtering, screen printing, vacuum depositing, etc. The metal on one side is formed into a high-resolution patch antenna 256 (using photolithography, screen printing and/or etching techniques) having a configuration and dimensions that are effective to form a microwave antenna. The metal layer on the other side of the dielectric substrate 258 is used as a ground plane 260 for signal transmission and/or reception. Figure 34(a) shows in an exploded view the components of an inventive shielded radiation patch antenna assembly 254 including the dielectric substrate 258, the patch antenna 256, the ground plane 260 and a radiation blocker/absorber and/or reflector member 262.

An exploded perspective view of an embodiment of a shielded radiation patch antenna assembly 254 in accordance with the present invention is shown in Figure 34(a). In accordance with the present invention, the patch antenna 256 may have tuning tabs 264. As is known in the prior art and disclosed, for example, in U.S. Patent No. 5,245,745, issued to Jensen et al., these tuning tabs 264 can be trimmed using, for example, a laser, to adjust the characteristics (such as the frequency, impedance an polarization) of the patch antenna 256 after it has been formed on the dielectric substrate 258. During a prefabrication test of the patch antenna 256 it may be determined to be defective due to unacceptable characteristics resulting from inconsistent material or fabrication methods. The defective antenna may be salvaged by adjusting the characteristics to overcome the defects, allowing a higher manufacturing yield.

Figure 34(b) is a perspective view of an assembled radiation patch antenna in accordance with the embodiment shown in Figure 34(a). The assembled radiation patch antenna can be manufactured using similar material and according to highly successful manufacturing techniques used for the fabrication of printed circuit boards and the like. Thus, the overall cost of the antenna is reduced, since existing manufacturing plant capacity can be utilized. In this embodiment, the patch antenna 256 has a feed through-hole 266 for receiving a signal line from the cellular telephone circuitry 138. Also, the ground plane 260 may be in electrical contact with the circuit ground of the circuitry 138 and/or battery 126. A shielded co-axial circuit cable (not shown) may be used for connection with the patch antenna 256 and/or the ground plane 260.

Figure 34(c) is a perspective view of an assembled shielded radiation patch antenna assembly 254 in accordance with the embodiment shown in Figure 34(a). The assembled radiation patch antenna (shown in Figure 34(b)) is received by the radiation blocker/absorber and/or reflector member 262. The radiation blocker/absorber and/or reflector member 262 may be integrally formed with, for example, the radiation shielding battery 126 or case member of the cellular telephone. Alternatively, the radiation blocker/absorber and/or reflector member 262 may be a separate unit mounted to the cellular telephone during assembly. The radiation blocker/absorber and/or reflector member 262 may comprise the radiation absorbing materials described herein, or other known absorbers, and may have a laminated layer structure including a combination of radiation blocker/absorber and/or reflector materials. The geometry of the components of the inventive shielded radiation patch antenna assembly 254 shown are for illustrative purposes, and other configurations and dimensions may be preferable depend on the application and desired characteristics. For example, the radiation blocker/absorber and/or reflector member 262 may have softer corners to be more effective at shielding the user from the emitted radiation, the ground plane 260, dielectric substrate 258 and patch antenna 256 may be shaped differently to obtain specific antenna characteristics, or to overcome defects due to inconsistent materials and/or fabrication steps.

Figures 35(a) through 35(c) show another embodiment of a shielded radiation patch antenna assembly 254 in accordance with the present invention. In this embodiment, an electromagnetic antenna feed radiator 268 is used to electromagnetically couple the transmission and/or reception signal between the telephone circuitry 138 and the patch antenna 256. The patch

antenna 256 is formed on one side of a first dielectric substrate 258, and the electromagnetic antenna feed radiator 268 comprises a conductor that is patterned on the opposite side of the dielectric substrate 258. The electromagnetic antenna feed radiator 268 is electrically connected with the telephone circuitry 138 through an antenna feed line 270. Dielectric spacers 272 may be provided adjacent to the electromagnetic antenna feed radiator 268 to maintain a space having certain electrical characteristics between the first dielectric substrate 258 and a second dielectric substrate 274. The second dielectric substrate 274 may be thicker than the first dielectric substrate 258 to electrically isolate the electromagnetic antenna feed radiator 268 from the ground plane 260. The shapes, thickness, locations and dimensions of the components of the inventive shielded radiation patch antenna assembly 254 depend on the particular application and desired characteristics. For example, the location and shape of the electromagnetic antenna feed radiator 268 relative to the patch antenna 256 (and/or ground plane 260) can be altered to obtain specific signal characteristics and to correct for defects due to inconsistent materials and/or fabrication techniques.

Figure 35(b) is a perspective view of an assembled radiation patch antenna 256 in accordance with the embodiment shown in Figure 35(a). The dielectric spacers 272 ensure that the electrical properties of the space between the patch antenna 256 and the ground plane 260 are controlled to produce an appropriate transmitted signal and/or received signal using the inventive antenna assembly. However, if the electromagnetic antenna feed radiator 268 is a thin film or nested into either the first or second dielectric substrate 258,274, then the dielectric spacers 272 may not be needed.

As shown in 35(c), when the antenna assembly is installed within the radiation blocker/absorber and/or reflector member 262, the antenna feed line 270 is accommodated in a notch 276 (or through-hole) formed in the radiation blocker/absorber and/or reflector member 262. Also, an electrical connecting line (not shown) for connecting the ground plane 260 with the telephone circuitry or battery may pass through another notch 276 or through-hole formed in the radiation blocker/absorber and/or reflector member 262.

Figures 36(a) and 36(b) show another embodiment of the inventive shielded radiation patch antenna assembly 254. In accordance with this embodiment, two or more patch antennas 256 are provided. By providing two or more patch antennas 256, different communication signals can be received and transmitted by the same antenna assembly and thus the cellular telephone can have a more universal use. For example, one patch antenna 256 may be used to transmit and/or receive communication signals having a frequency and polarization effective for communication using a terrestrial based cellular phone system. The other patch antenna 256 may be used to transmit and/or receive communication signals having a different frequency and/or polarization (or other different characteristics), or for example, a satellite based telephone communication system, paging system, radiotelephone system, telepoint system, etc. The shape, composition, configuration and location of the components of the shielded radiation patch antenna assembly 254 may be selected depending on the intended use. For example, the electromagnetic antenna feed radiator(s) 268 may be replaced with shielded co-axial cable(s), etc. In accordance with this feature, a single cellular

telephone is simultaneously receptive of different transmitted signals. Thus, a user needs only one communication device to communicate via a variety of radio-based systems.

Figure 37 is an exploded perspective view of another embodiment of a shielded radiation patch antenna assembly 254. In accordance with this embodiment, at least one (two are shown) patch antennas 256 are formed adjacent to a first dielectric substrate 258. A corresponding ground plane 260 is formed adjacent to the opposite side of the dielectric substrate 258. An antenna feed 278 is formed adjacent to a second dielectric substrate 274 separating the antenna feed 278 from the ground plane 260. The ground plane 260 may have an aperture 280 to electromagnetically couple a signal between the patch antenna 256 and the antenna feed 278. As known in the prior art, and disclosed, for example, in U.S. Patent No. 5,241,321, issued to Tsao, interaction of the antenna feed 278 with the aperture 280 of the ground plane 260 produces a polarized radiation signal. The shape, location, dimensions and composition of the components of the inventive antenna assembly can be varied depending on the application and/or to correct defects due to inconsistent material and/or fabrication processes. For example, the orientation and shape of the antenna feed 278 and/or aperture 280 may be altered to produce a signal having a particular polarization, depending on the type of communication system on which the patch antenna 256 will be used.

Figure 38 is a side perspective view of another embodiment of the inventive cellular telephone having grip disposing surfaces and having a shielded radiation patch antenna assembly 254. As shown, the inventive shielded radiation patch antenna assembly 254 may be used as a transmission antenna assembly along with an unshielded receiving antenna 190. Of course, the patch antenna 256 can be used for reception and the receiving antenna 190 may not be necessary, depending on the positioning of the radiation blocker/absorber and/or reflector member 262 and its shielding effect.

With respect to the above description, it is realized that the optimum dimensional relationships for parts of the invention, including variations in size, materials, shape, form, function, and manner of operation, assembly and use, are deemed readily apparent and obvious to one skilled in the art. All equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed by the present invention.

Therefore, the foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described. Accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

Claims:

1. A method of shielding an electronic circuit component, characterized by the steps of: providing an electronic component; and providing a radiation shielding battery disposed adjacent to the electronic component, the battery being comprised of at least one shielding material being effective for shielding electromagnetic radiation.

2. A method of shielding an electronic circuit component according to claim 1; further comprising the step of providing the battery comprising a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and an electrolyte disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

3. A method of shielding an electronic circuit component according to claim 2; further comprising the step of electrically grounding the electronic component to the electrically negative side of the battery.

4. A method of shielding an electronic circuit according to claim 1; further comprising the steps of forming the battery into a hollow shape defining an electrically shielded interior space; and disposing the electronic component within the electrically shielded interior space.

5. A method of shielding an electronic circuit component according to claim 4; further comprising the step of providing the hollow shape having at least one open end; and further comprising the step of fixing a shielding cap member to electronically close said at least one open end.

6. A method of shielding an electronic circuit component according to claim 1; further comprising the step of fixing the battery to a case shell substrate to form a case member having at least a portion of at least one wall comprised of the case shell substrate and the battery.

7. A method of shielding an electronic circuit component according to claim 1; further comprising the step of providing the battery comprising a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and a plasitc electrolyte formed by impregnating a plasitc with a liquid electrolyte, the plastic electrolyte being disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

8. A cellular telephone, characterized by: radiation emitting cellular telephone circuitry for emitting microwave radiation; an antenna assembly for emitting microwave radiation; and shielding

means disposable during use for shielding a user of the cellular telephone from at least one the microwave radiation emitted from the cellular telephone circuitry and the microwave radiation emitted from the antenna assembly, the shielding means comprising a radiation shielding battery disposed adjacent to at least one of the cellular telephone circuitry and the antenna assembly, the battery being comprised of at least one shielding material being effective for shielding microwave radiation..

9. A cellular telephone according to claim 8; wherein the battery comprises a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and an electrolyte disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

10. A cellular telephone according to claim 8; wherein the battery is formed into a hollow shape defining an electrically shielded interior space for containing the cellular telephone circuitry within the electrically shielded interior space.

11. A cellular telephone according to claim 8; wherein battery defines the hollow shape having at least one open end; and further comprising a shielding cap member to electronically close said at least one open end.

12. A cellular telephone according to claim 8; further comprising a case shell substrate fixed to the battery for forming a case member having at least a portion of at least one wall comprised of the case shell substrate and the battery.

13. A celluar telephone according to claim 8; wherein the battery comprises a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and a plasitc electrolyte formed by impregnating a plasitc with a liquid electrolyte, the plastic electrolyte being disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

14. An antenna assembly for a radio transmitting device, comprising: a first antenna for receiving electromagnetic radiation from a remote source; a second antenna for emitting electromagnetic radiation from the radio transmitting device to a remote receiver; and shielding means disposed during use of the radio transmitting device between the second antenna and a user so as to be effective to shield the user from at least some of the electromagnetic radiation emanating from the second antenna toward the user while allowing at least some of the electromagnetic

radiation emanating from the second antenna not toward the user to be transmitted, so that exposure of the user to potentially harmful radiation from the antenna is prevented while allowing the second antenna member to transmit the electromagnetic radiation from the radio transmitting device to the remote receiver, and allowing the first antenna to receive electromagnetic radiation from the remote source.

15. An antenna assembly according to claim 14; wherein the shielding means comprises at least one of an electromagnetic radiation absorber, an electromagnetic radiation absorber and an electromagnetic radiation reflector.

16. A antenna assembly according to claim 14; wherein the shielding means comprises a radiation shielding battery disposed adjacent to the second antenna, the battery being comprised of at least one shielding material being effective for shielding electromagnetic radiation.

17. An antenna assembly according to claim 16; wherein the radiation shielding battery comprises a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and an electrolyte disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

18. An antenna assembly according to claim 16; wherein the battery comprises a negative planar electrode disposed at an electrically negative side of the battery, a positive planar electrode disposed at an electrically positive side of the battery, and a plasitc electrolyte formed by impregnating a plasitc with a liquid electrolyte, the plastic electrolyte being disposed between the negative planer electrode and the positive planar electrode, at least one of the negative planar electrode and the positive planar electrode being said at least one shielding material for shielding electromagnetic radiation.

19. An antenna assembly according to claim 16; wherein the battery further compries a radiation absorbing layer.

20. An antenna assembly according to claim 16; wherein the battery is formed into a concave shape defining a space for accomodating the second antenna.

AMENDED CLAIMS
[received by the International Bureau
on 18 October 1995 (18.10.95);
new claims 21-45 added; remaining claims unchanged (5 pages)]

21. A radiation shielding apparatus for a radio signal transmitting device, the radiation shielding apparatus characterized by: shielding means disposed during use between a radiation emanating component comprising an electromagnetic radiation transmitting antenna of a radio signal transmitting device and a user, the electromagnetic radiation transmitting antenna comprising at least one of an internal antenna disposed in the interior of the radio signal transmitting device and an external antenna disposed on the exterior of the radio signal transmitting device, the shielding means for preventing unwanted exposure of the user to emanating radiation from the electromagnetic radiation transmitting antenna.

22. A radiation shielding apparatus for a radio signal transmitting device according to claim 21; wherein the radiation emanating component further comprises an electromagnetic radiation source disposed in the interior of the radio signal transmitting device.

23. A radiation shielding apparatus for a radio signal transmitting device according to claim 21; wherein the shielding means comprises a radiation shield dimensioned to be retrofitted to an existing radio signal transmitting device.

24. A radiation shielding apparatus for a radio signal transmitting device according to claim 21; wherein the shielding means comprises at least one of an electromagnetic radiation reflector, an electromagnetic radiation absorber and an electromagnetic radiation blocker.

25. A radiation shielding device for a radio signal transmitting device according to claim 21; wherein radio signal transmitting device is a cellular telephone; and the electromagnetic radiation transmitting antenna transmits electromagnetic radiation in a cellular frequency band.

26. A radiation shielding apparatus for a radio signal transmitting device according to claim 25; wherein the electromagnetic radiation transmitting antenna transmits electromagnetic radiation at a frequency between 800 and 900 megahertz.

27. A radiation shielding apparatus for a radio signal transmitting device according to claim 26; wherein the shielding means comprises at least one of an electromagnetic radiation reflector, an electromagnetic radiation absorber an electromagnetic radiation blocker.

28. A radiation shielding apparatus for a radio signal transmitting device according to claim 21; further comprising fixing means for disposing, fixing and maintaining the shielding means at an operable position between the electromagnetic radiation transmitting antenna and the user.

29. An electrical power supply for an electronic device, characterized by: an internal battery for powering an electronic device, the internal battery being disposed with a case member for containing the electronic device; an external battery connectable with the case member for powering the electronic device; a back-up battery disposable within the case member for powering the electronic device; and switching means for switching a connection between the electronic device and the internal battery, the external battery and the back-up battery so that the electronic device is powered at different times by at least one of the internal battery, the external battery and the back-up battery.

30. An electric power supply according to claim 29; further comprising controlling means for determining an existence and a state of charge of at least one of the internal battery, the external battery and the back-up battery and for controlling the switching means depending on a determined existence and state of charge of said at least one of the internal battery, the external battery and the back-up battery.

31. An electric power supply according to claim 29; wherein the internal battery comprises a radiation shielding battery comprising at least one shielding material being effective for electrically shielding electromagnetic radiation.

32. A case for shielding a user of a radio signal transmitting device from radiation, the case characterized by: a protective case member configured and dimensioned to receive a radio signal transmitting device within an interior volume defined by the protective case member, the protective case member including a radiation shielding layer for preventing transmission through the protective case member of electromagnetic radiation emitted from the radio signal transmitting device.

33. A case for shielding a user of a radio signal transmitting device according to claim 32; wherein the protective case member includes an outer layer disposed adjacent to the radiation shielding layer, the outer layer comprising a durable material.

34. A case for shielding a user of a radio signal transmitting device according to claim 31; wherein the radiation shielding layer includes a metallic foil.

35. A case for shielding a user of a radio signal transmitting device according to claim 31; further comprising a grounding wire for electrically connecting the radiation shielding layer to an electrical ground of the radio signal transmitting device.

36. An electronic circuit for a radio signal transmitting device, the electronic circuit characterized by: a features circuit comprising at least one of a speaker volume increasing circuit, a call timer circuit, a recording circuit, a call screener circuit, an external speaker jack and a modem/fax port.

37. An electronic circuit according to claim 36; wherein the speaker volume increasing circuit comprises a microphone, and amplifier and a speaker.

38. An electronic circuit according to claim 36; wherein the call timer circuit comprises determining means for determining a predetermined length of time elapsing during use of the radio signal transmitting device, and audible signal generating means for generating an audible signal when the predetermined length of time elapses.

39. An electronic circuit according to claim 36; wherein the recording circuit includes a memory integrated circuit device for storing audible information.

40. An antenna assembly for a radio signal transmitting device, the antenna assembly characterized by: a driven antenna member for transmitting a radio signal from the radio signal transmitting device; shielding means disposed between the driven antenna member and a user of the radio signal transmitting device for shielding the user from the transmitted radio signal from the driven antenna member.

41. An antenna assembly according to claim 40; wherein the driven antenna member comprises a patch antenna comprised of a thin film of conductive material formed on a dielectric substrate.

42. A handset housing of a radio signal transmitting device, characterized by: a handset housing for containing internal circuitry of a radio signal transmitting device, the handset housing having an outer surface area; a grip disposing surface disposed at predetermined locations of the outer surface area, the grip disposing surface having a tactile texture when touched by a hand of a user of the radio signal transmitting device; and non-gripping surface disposed at other predetermined locations of the outer surface area, the non-gripping surface having a different tactile texture different than the tactile texture of the grip disposing surface when touched by a hand of the user, so that the user can easily distinguish between the grip disposing surface and the non-gripping surface.

43. A handset housing according to claim 42; wherein the grip disposing surface is relatively soft; and the non-gripping surface is relatively hard.

44. A modular unit for a radio signal transmitting device, characterized by: a modular unit housing for containing a feature electronic circuit and a connection jack for electrically connecting the feature electronic circuit with a radio signal transmitting device.

45. A modular unit according to claim 44; wherein the feature electronic circuit comprises a memory for storing predetermined data, the predetermined data being effective for customizing use of the radio signal transmitting device.

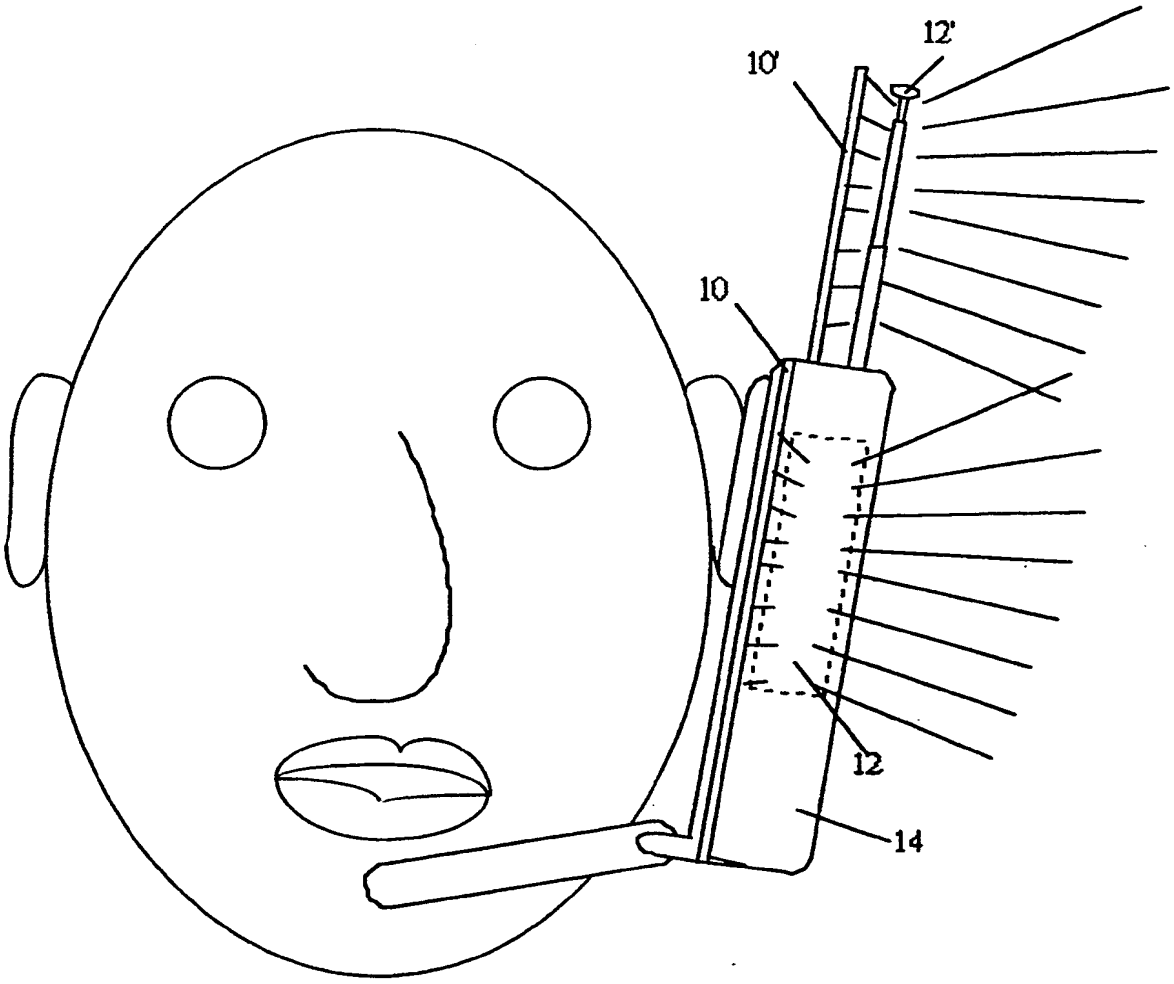


Figure 1

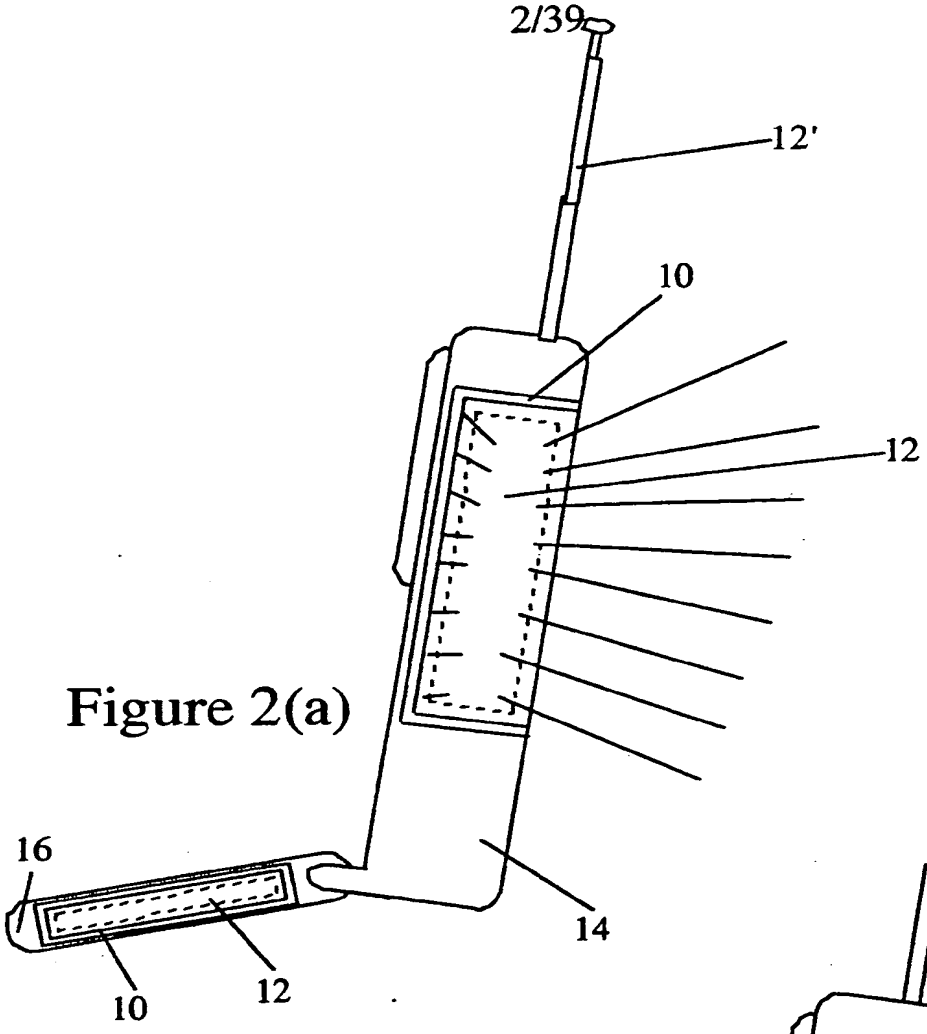


Figure 2(a)

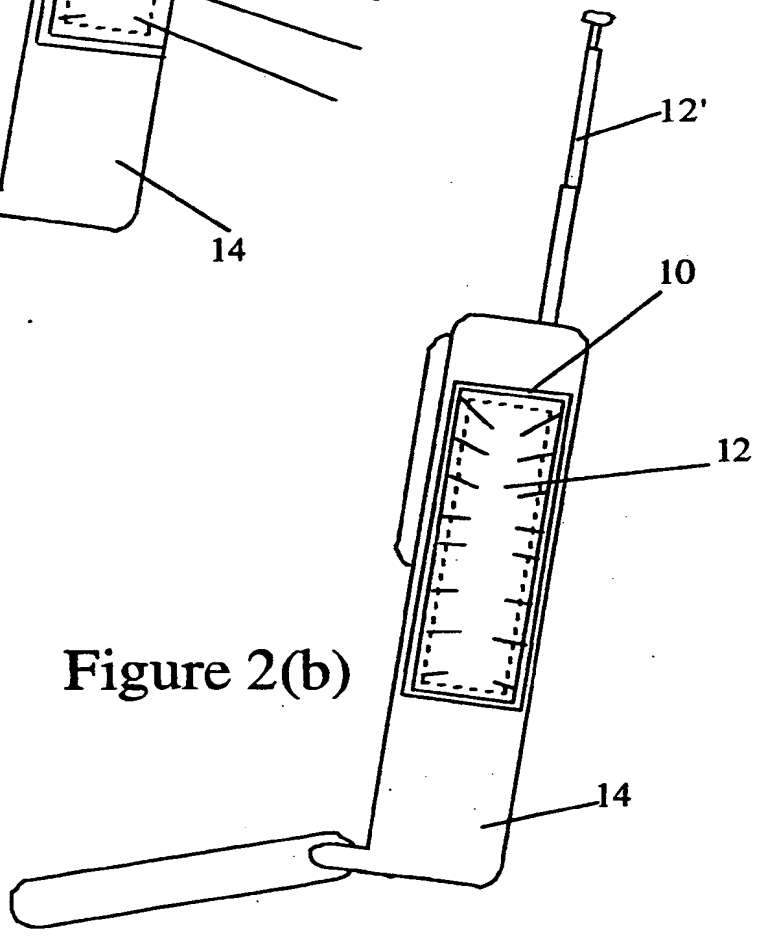


Figure 2(b)

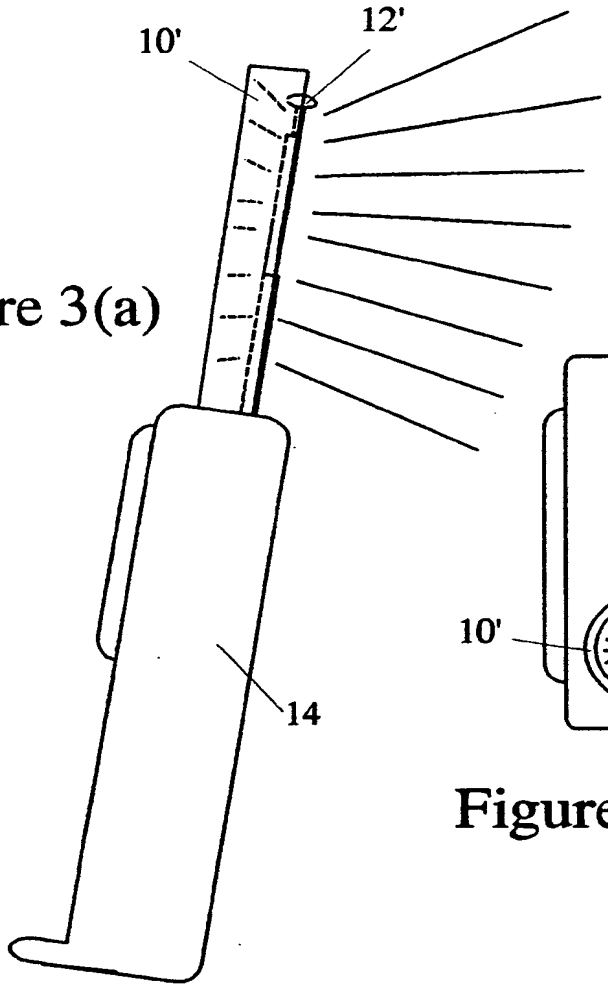


Figure 3(a)

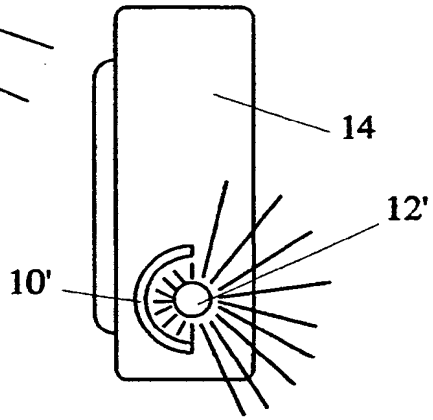


Figure 3(b)

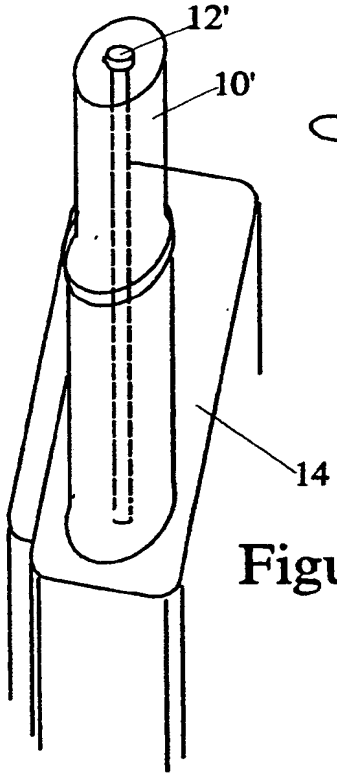


Figure 3(c)

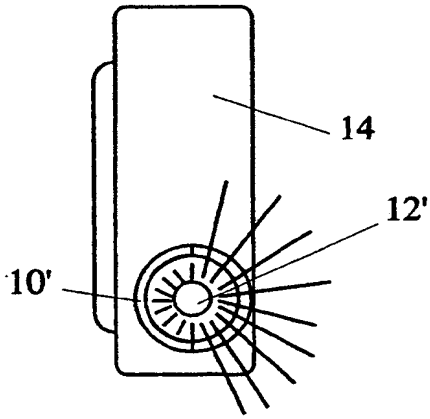


Figure 3(d)

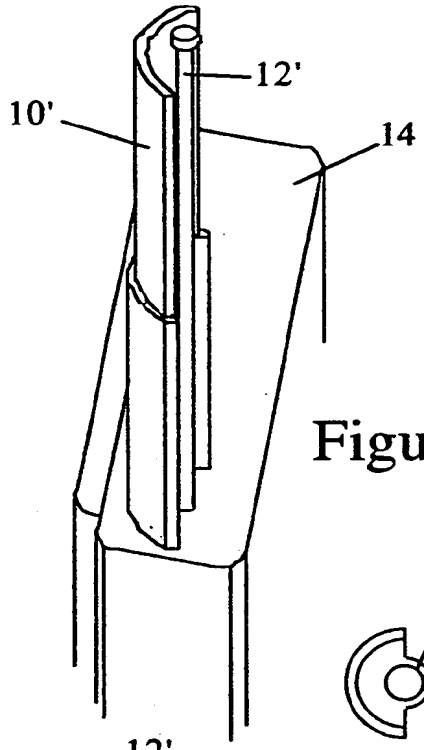


Figure 4(a)

Figure 4(c)

Figure 4(d)

Figure 4(e)

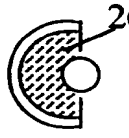


Figure 4(f)

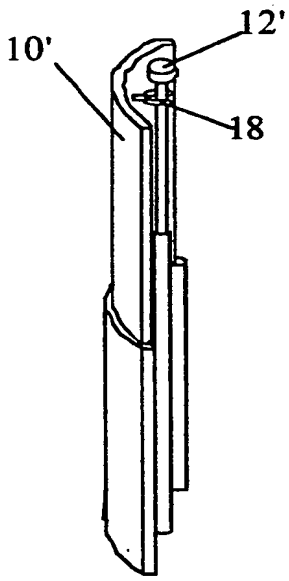


Figure 4(b)

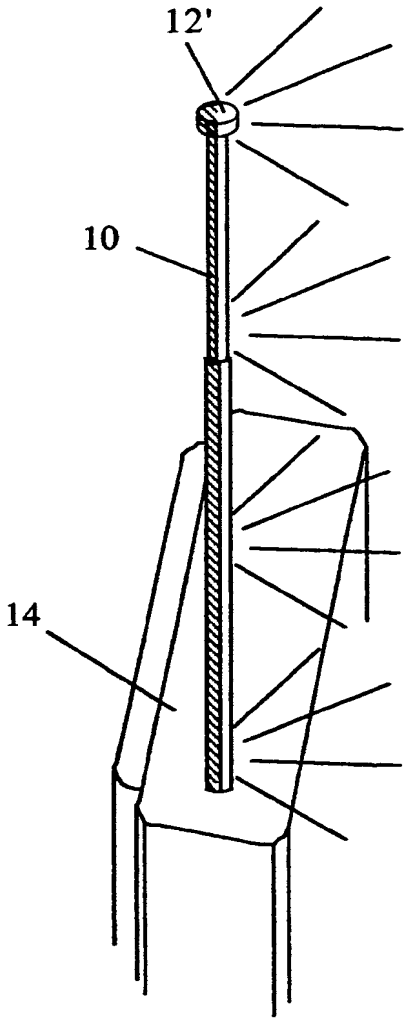


Figure 5

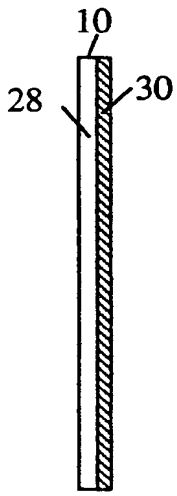


Figure 6(a)

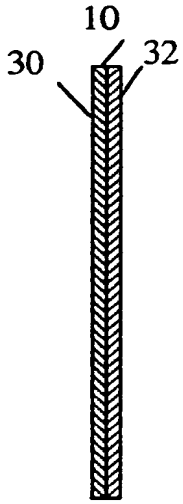


Figure 6(d)

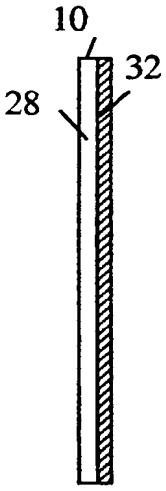


Figure 6(b)

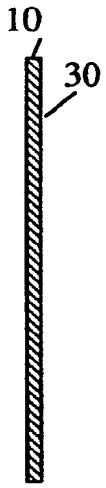


Figure 6(e)

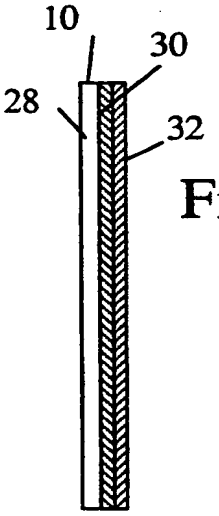


Figure 6(c)

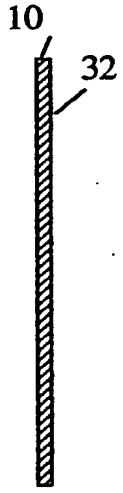


Figure 6(f)

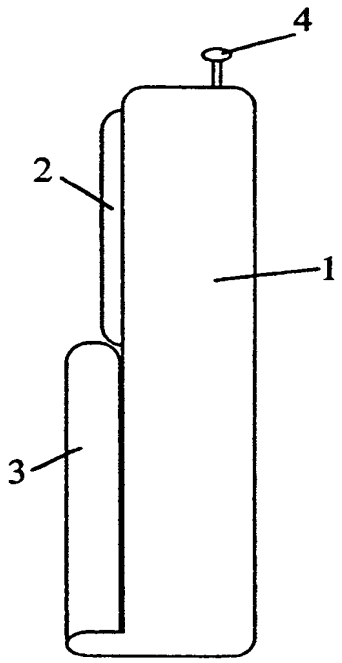


Figure 7
Prior Art

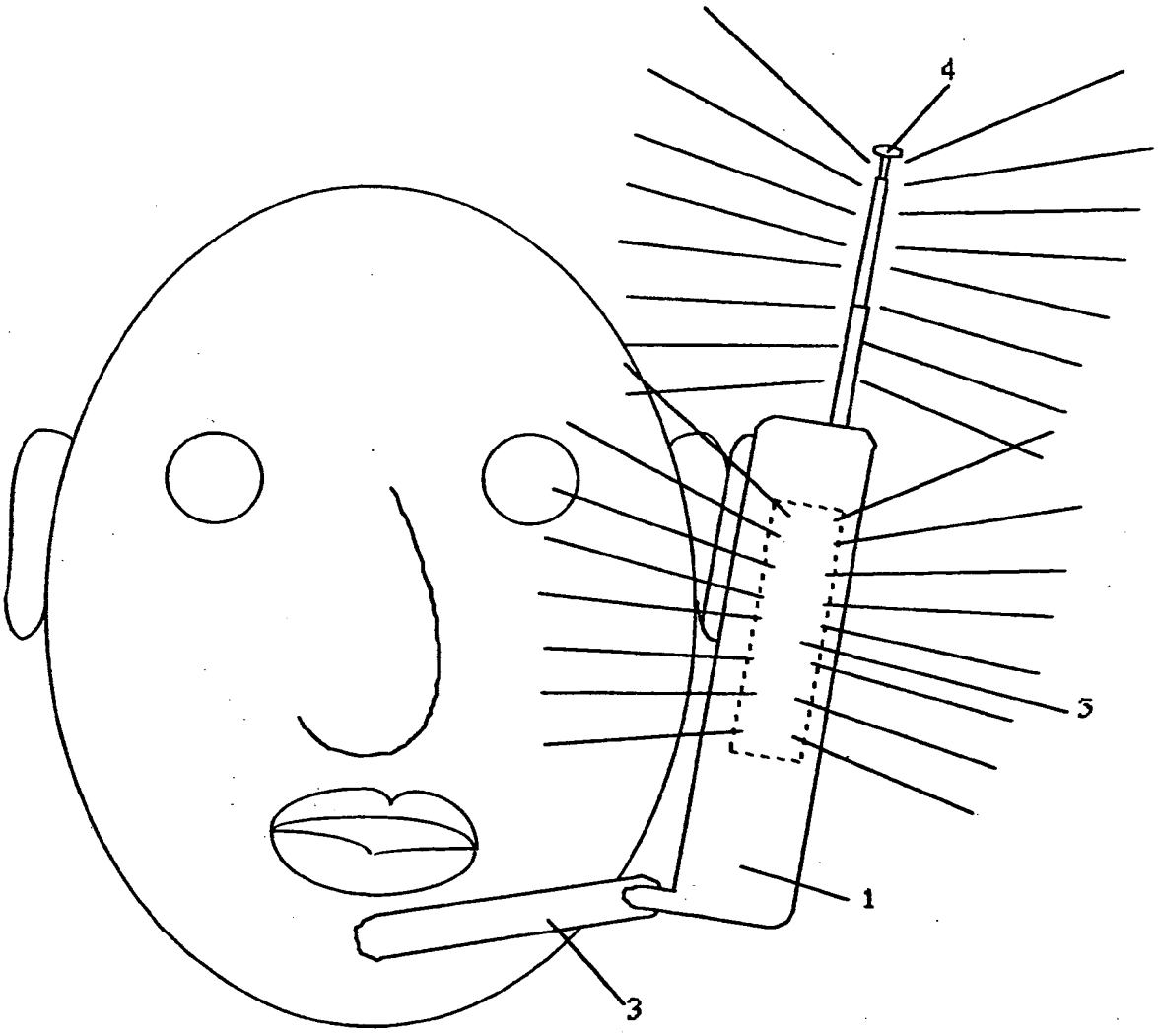


Figure 8
Prior Art

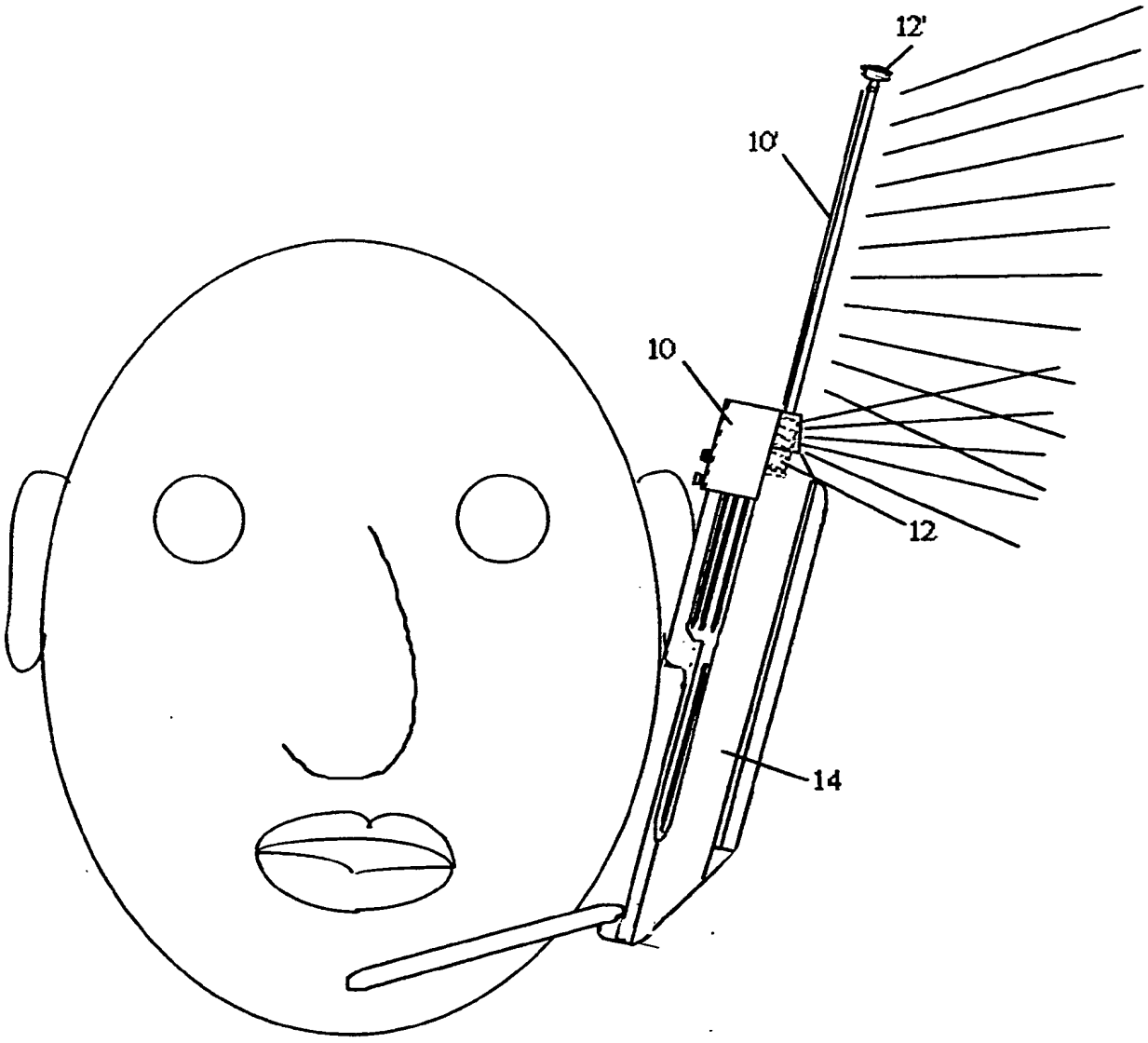


Figure 9

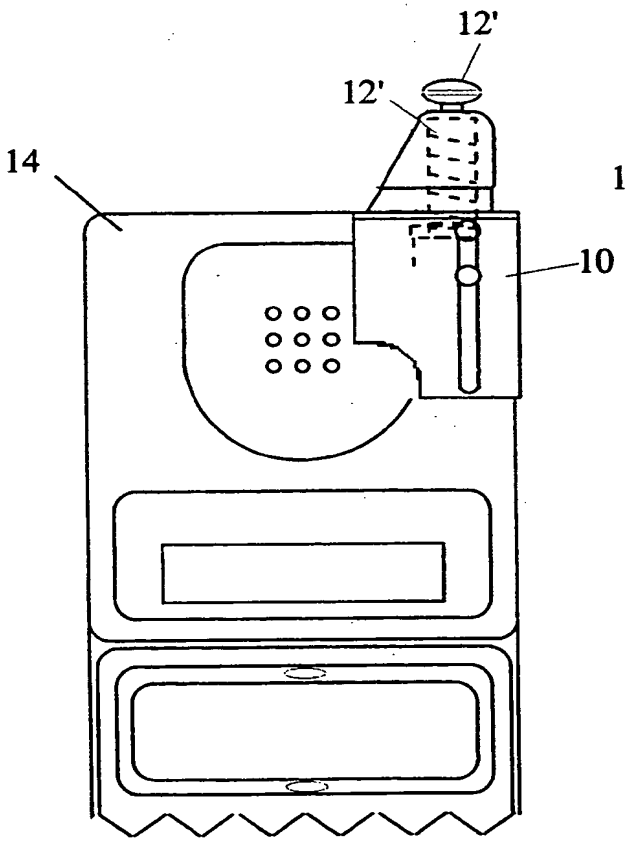


Figure 10(a)

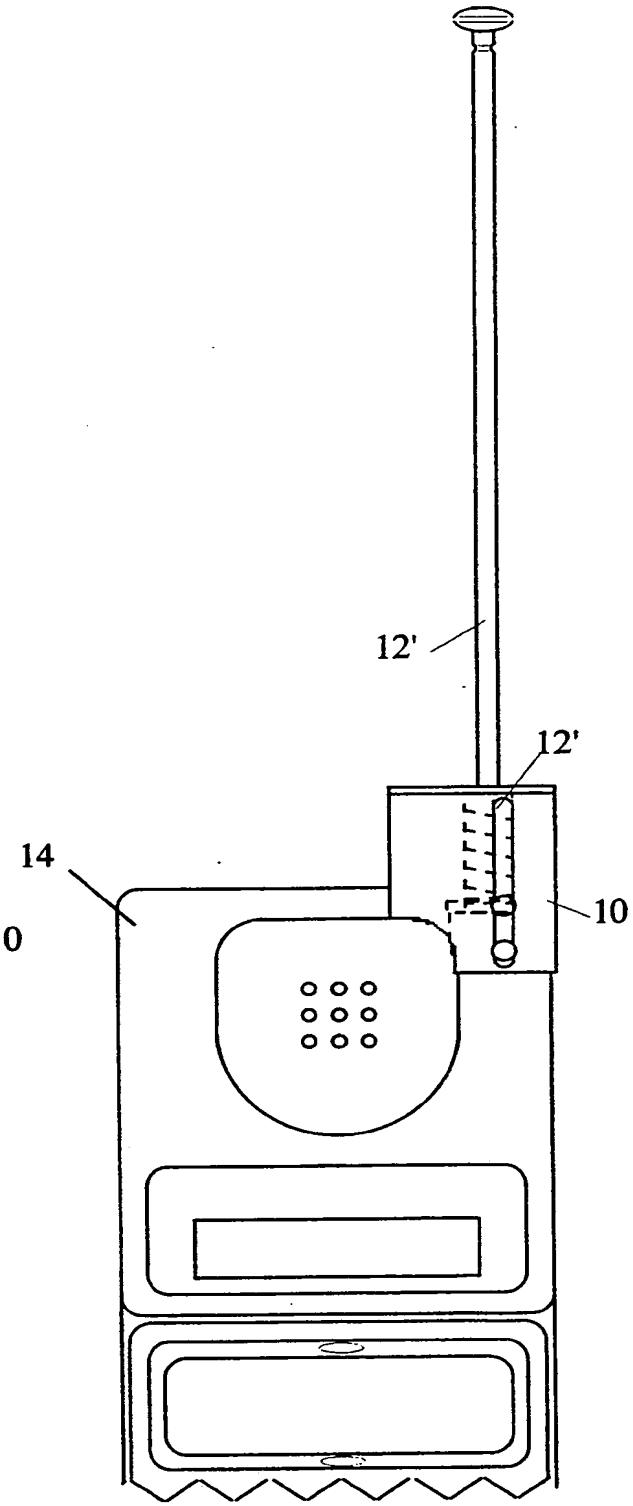


Figure 10(b)

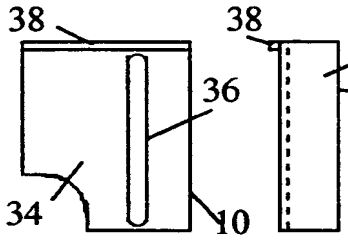


Figure 11(a)

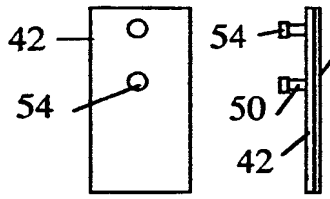


Figure 11(b)

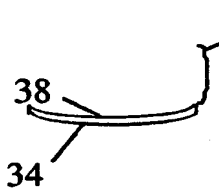


Figure 11(c)

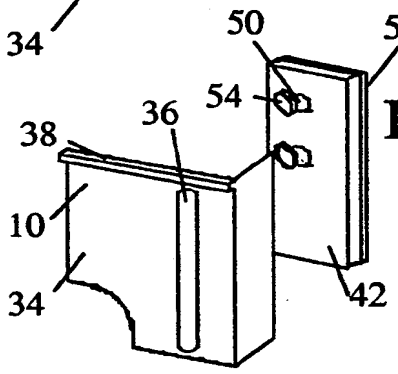


Figure 11(d)

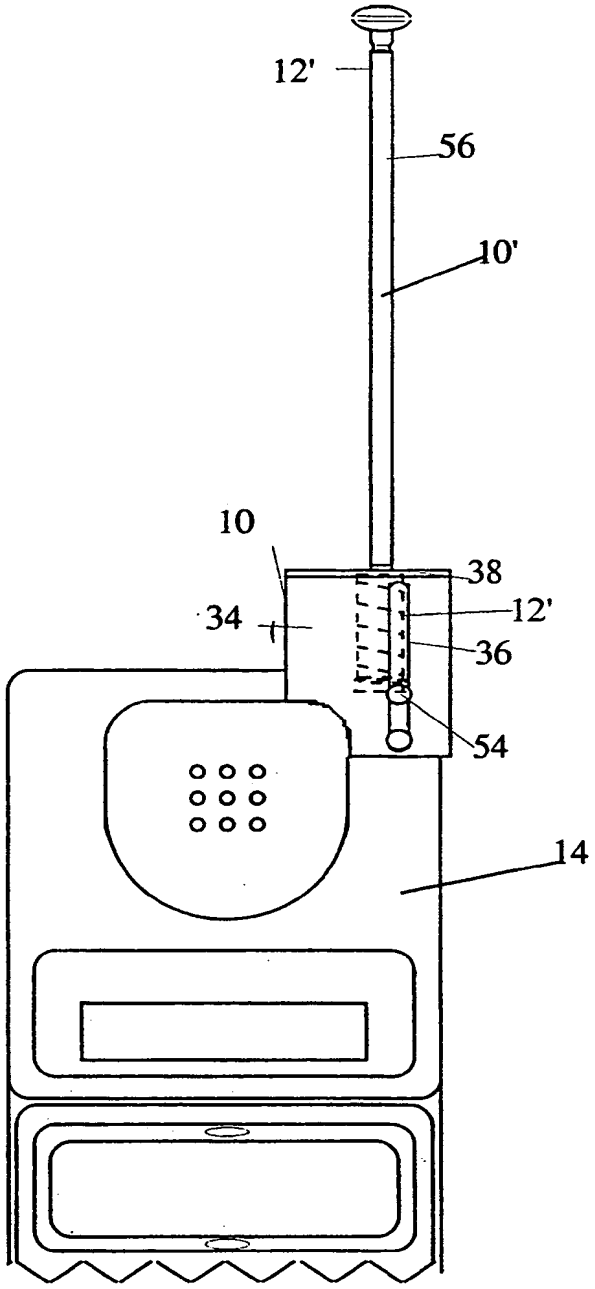


Figure12(a)

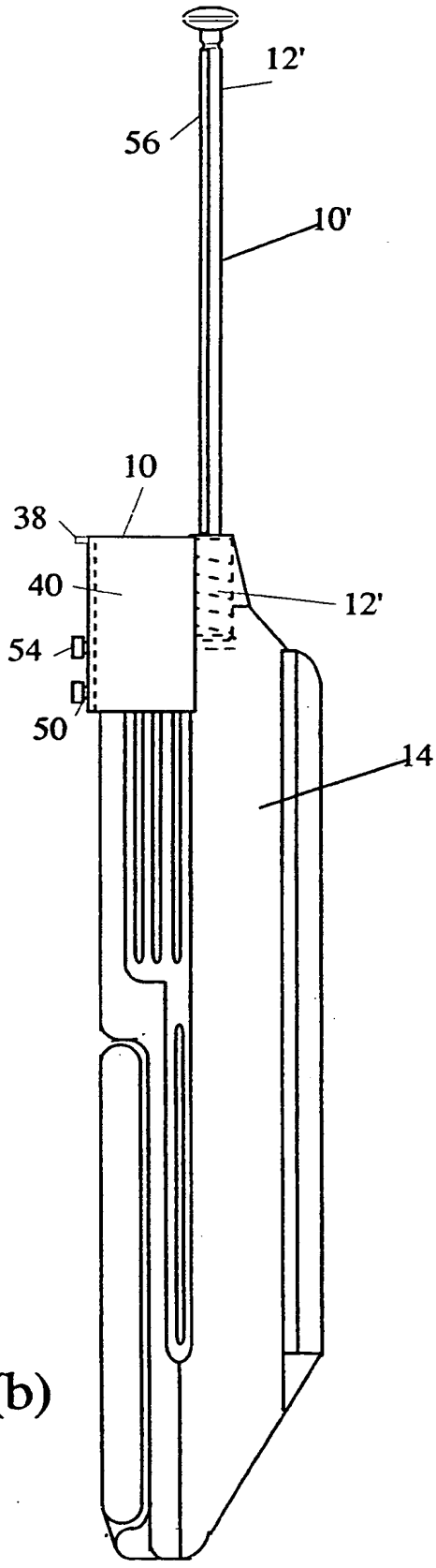


Figure 12(b)

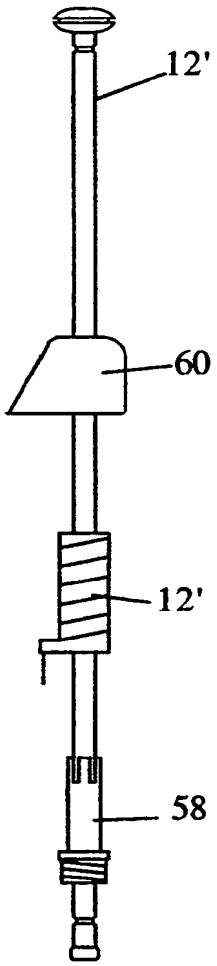


Figure 13

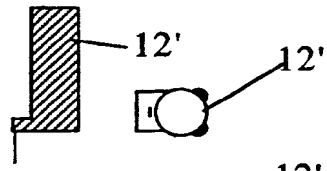


Figure 14(a)
Prior Art

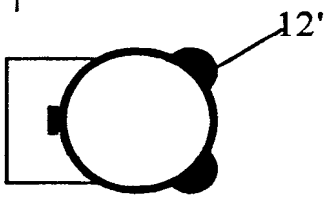


Figure 14(b)
Prior Art

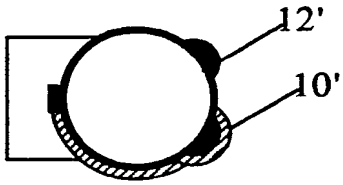


Figure 14(c)

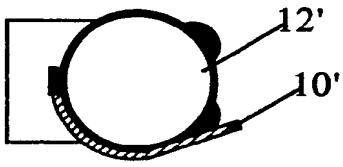


Figure 14(d)

Figure 15(a)
Prior Art

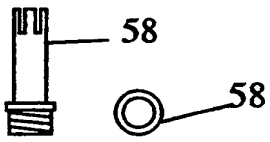


Figure 15(b)
Prior Art

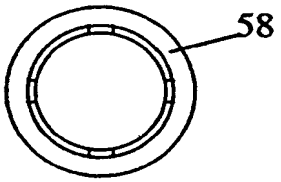
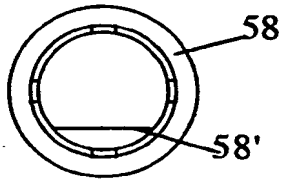


Figure 15(c)



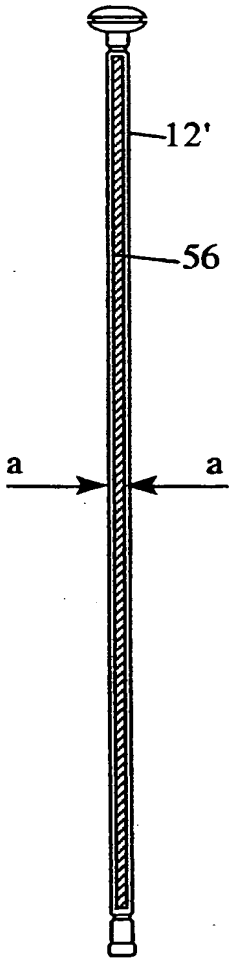


Figure 16(a)

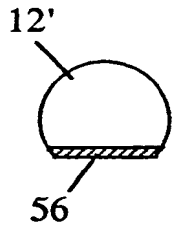


Figure 16(b)

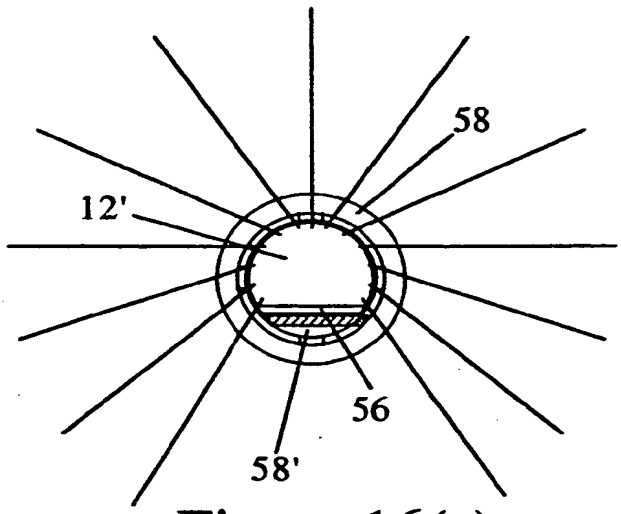


Figure 16(c)

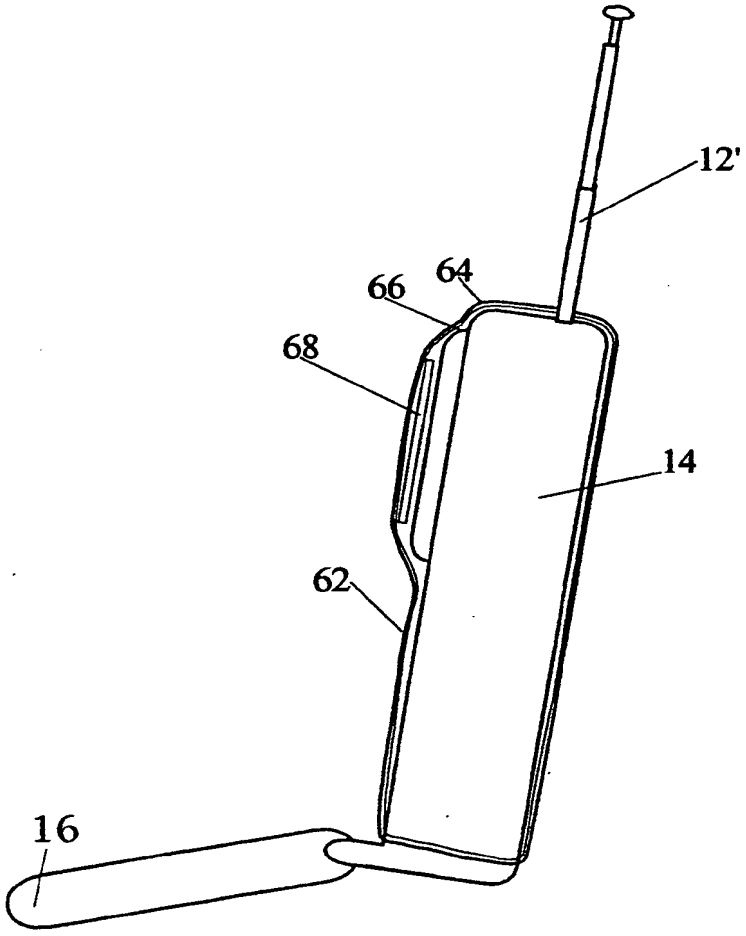


Figure 17

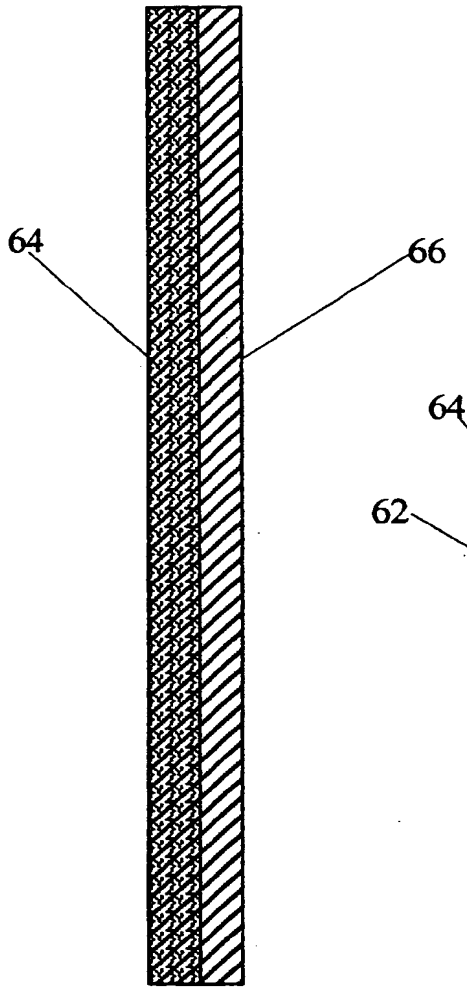


Figure 18(a)

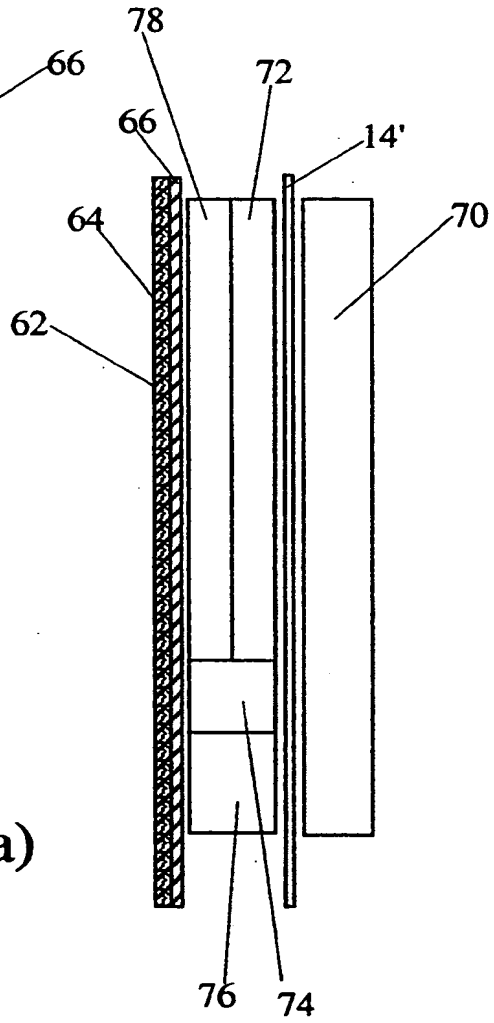


Figure 18(b)

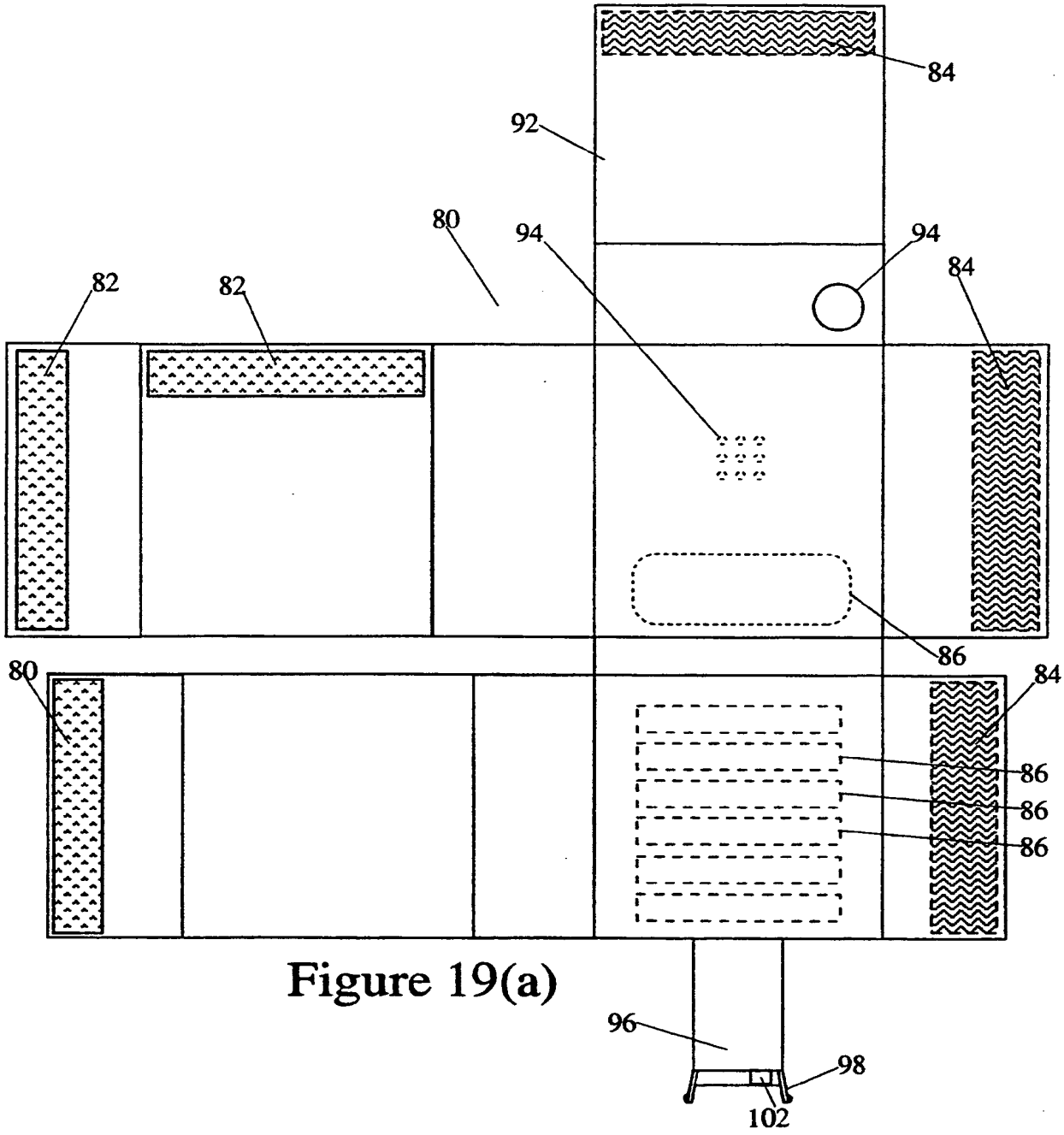


Figure 19(a)

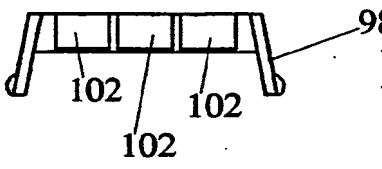


Figure 19(b)

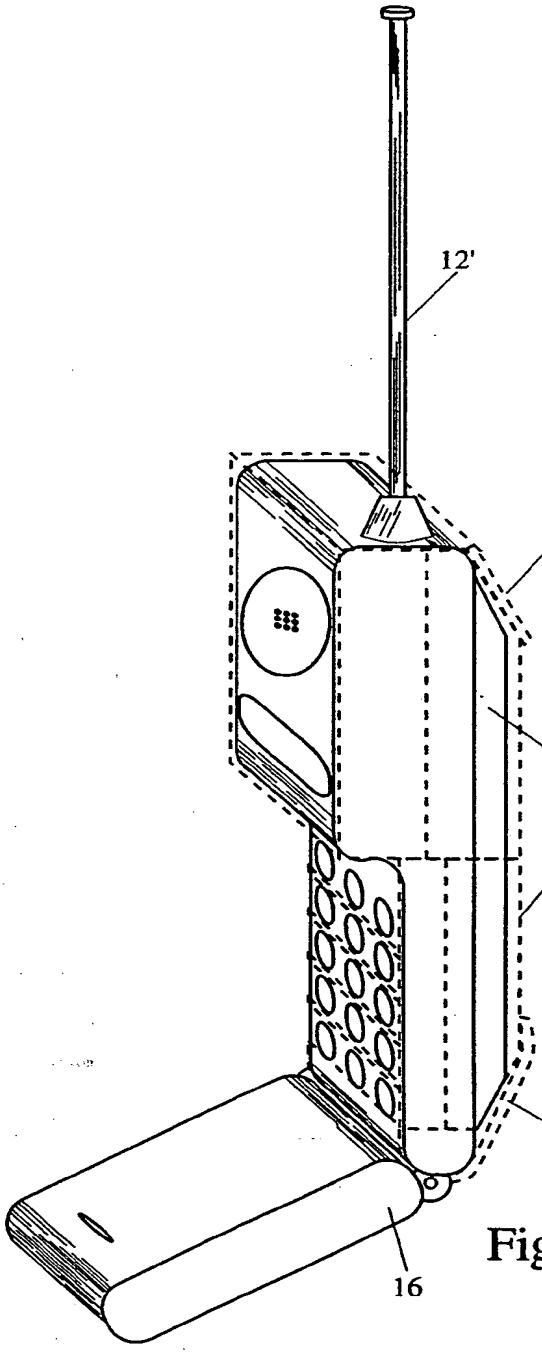


Figure 20(a)

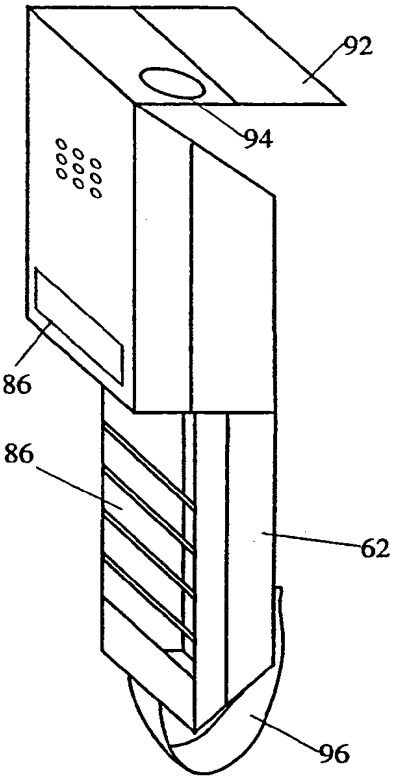


Figure 20(b)

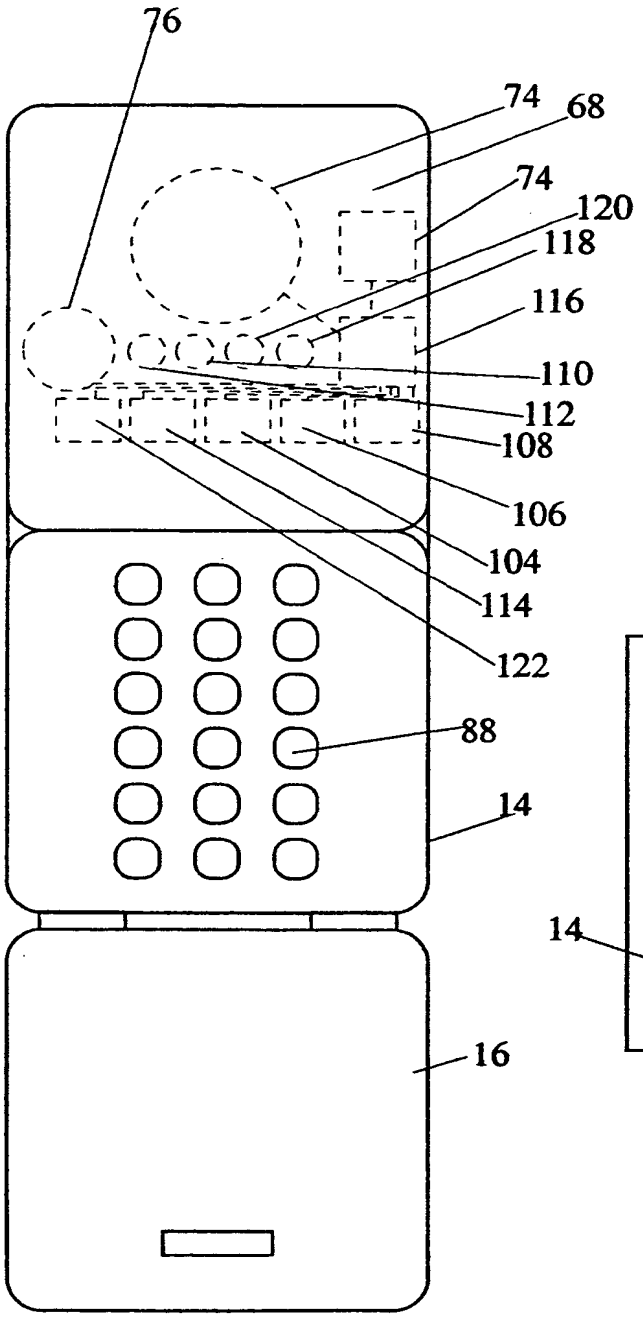


Figure 21(a)

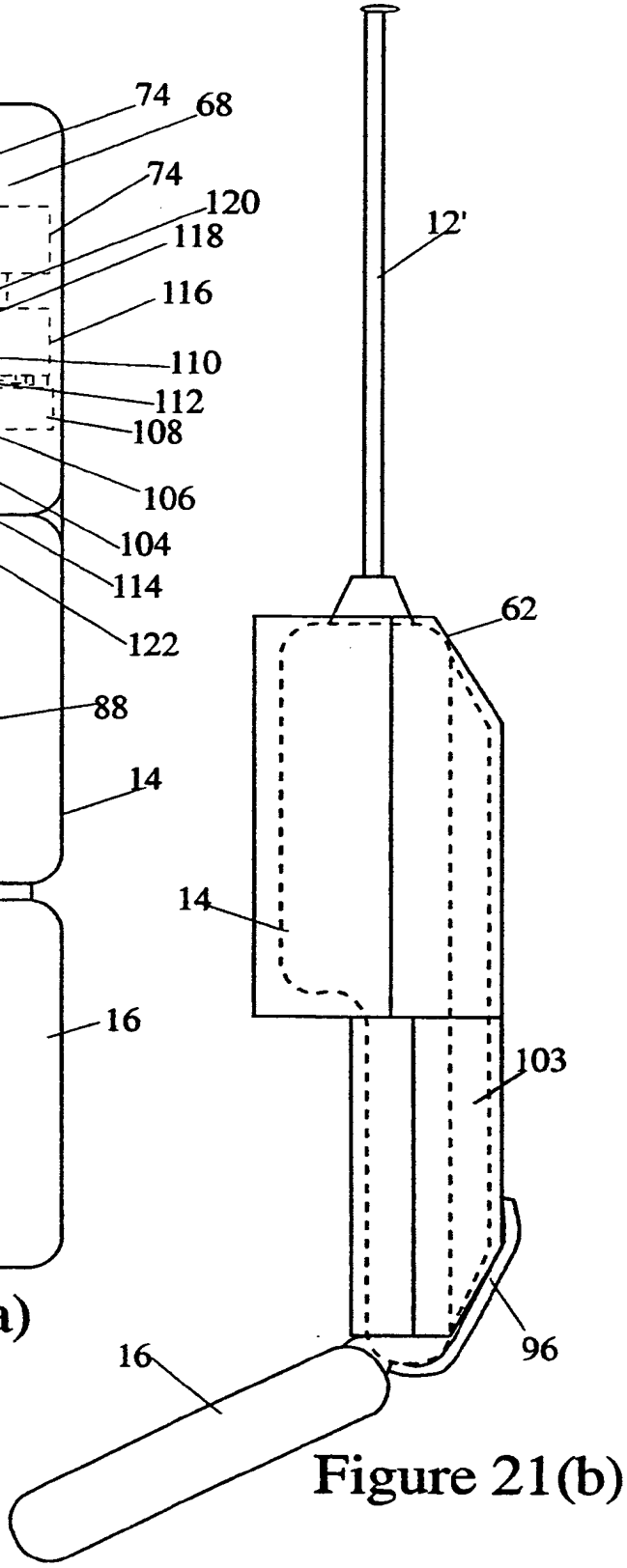


Figure 21(b)

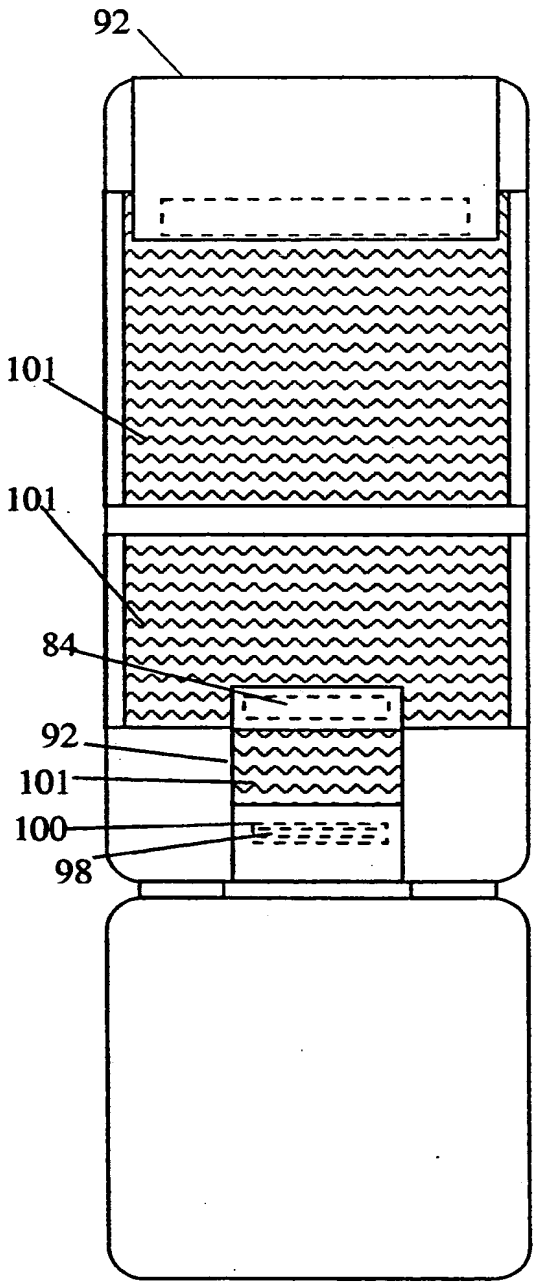


Figure 21(c)

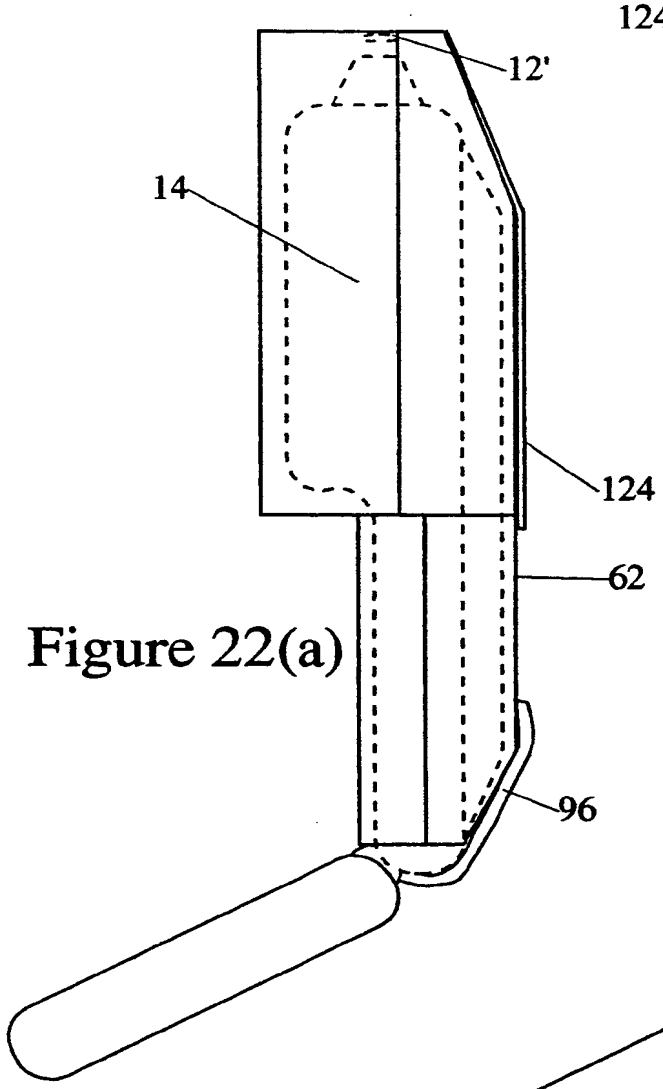


Figure 22(a)

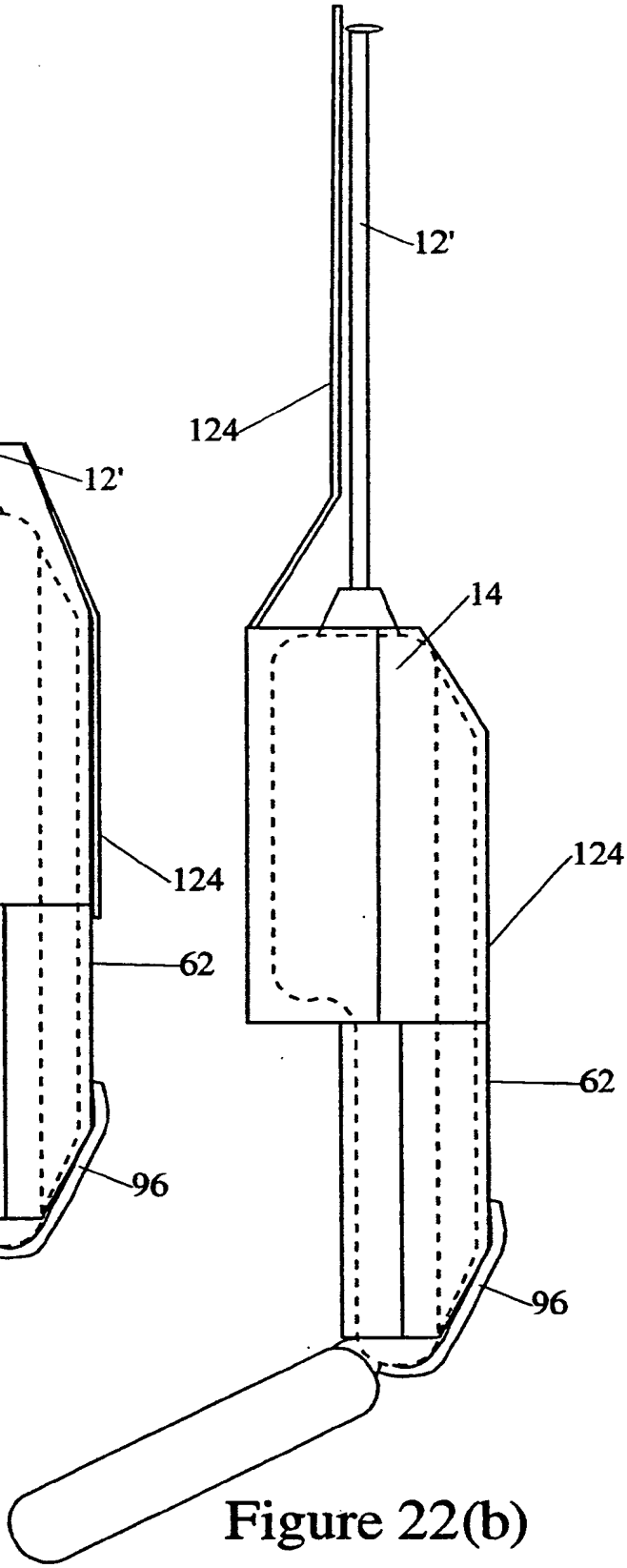


Figure 22(b)

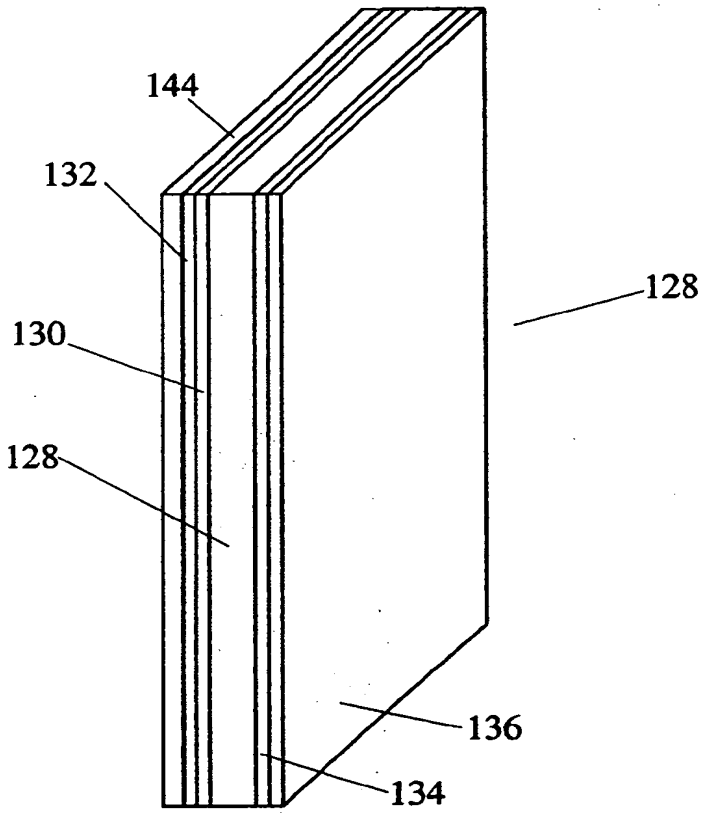


Figure 23(a)

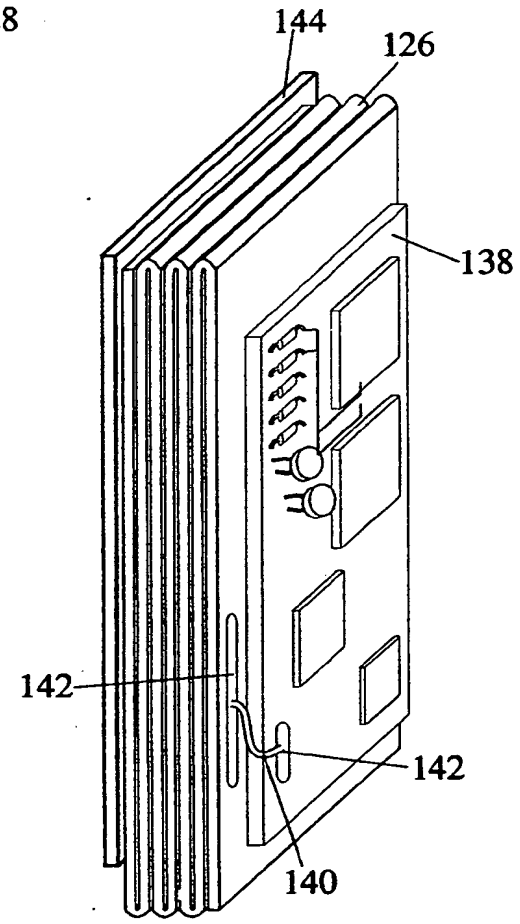


Figure 23(b)

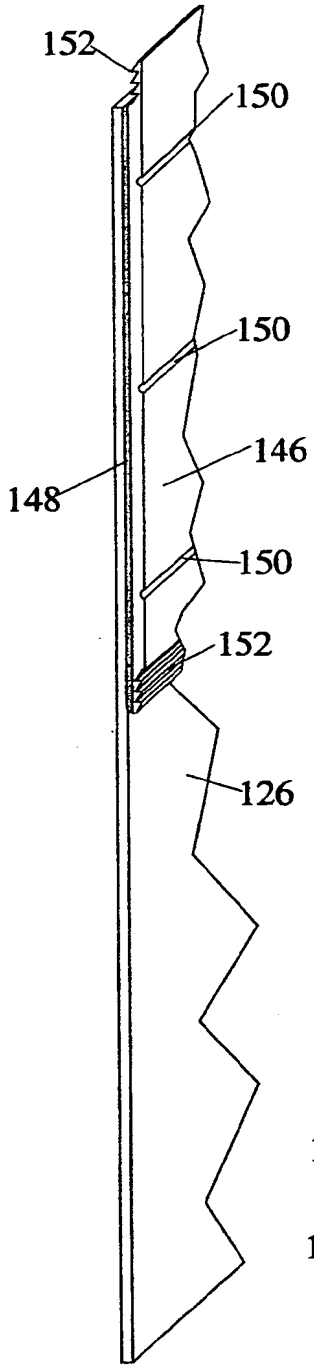


Figure 24(a)

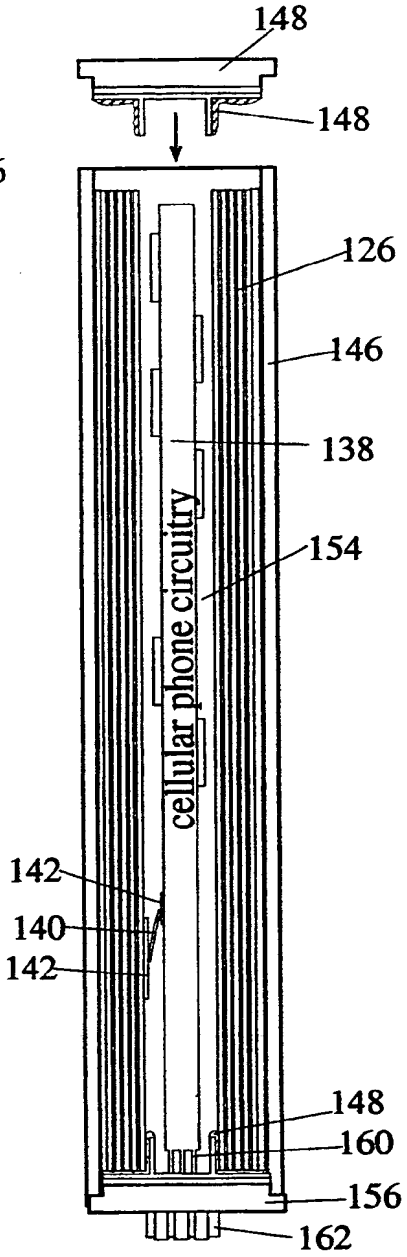


Figure 24(c)

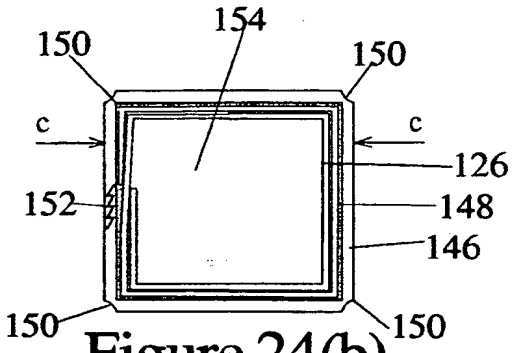


Figure 24(b)

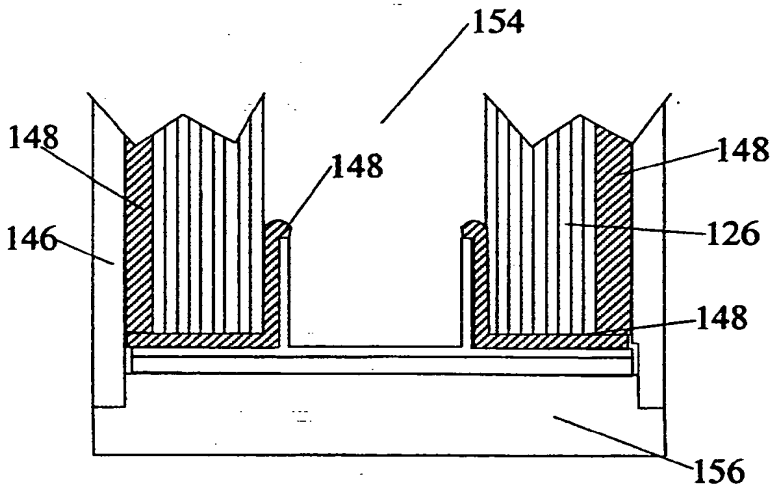


Figure 24(d)

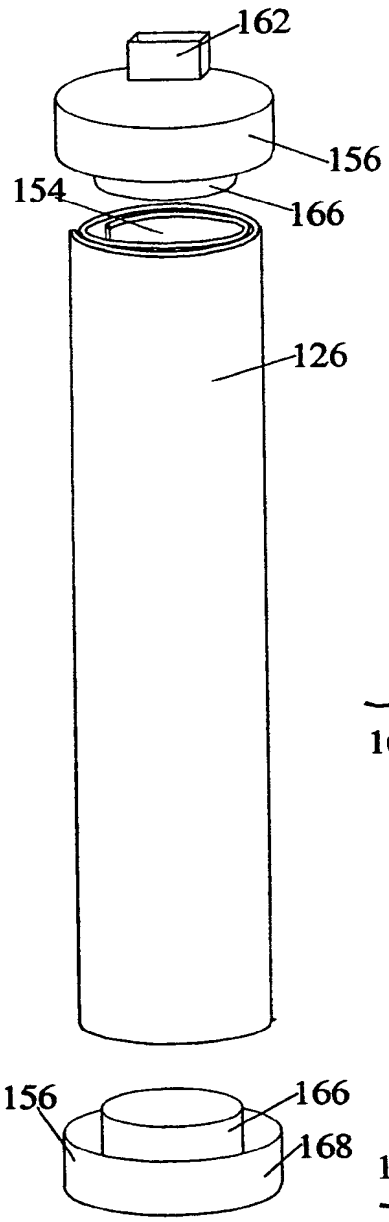


Figure 25(a)

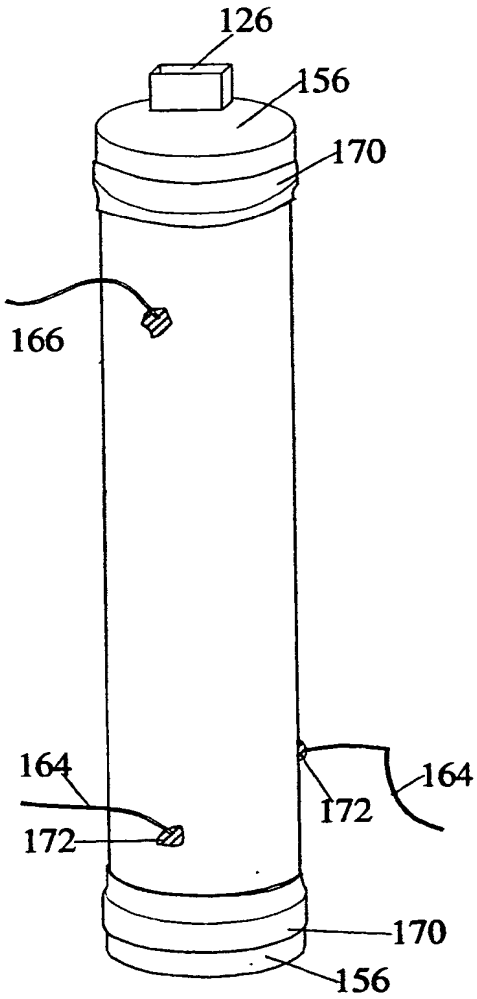


Figure 25(b)

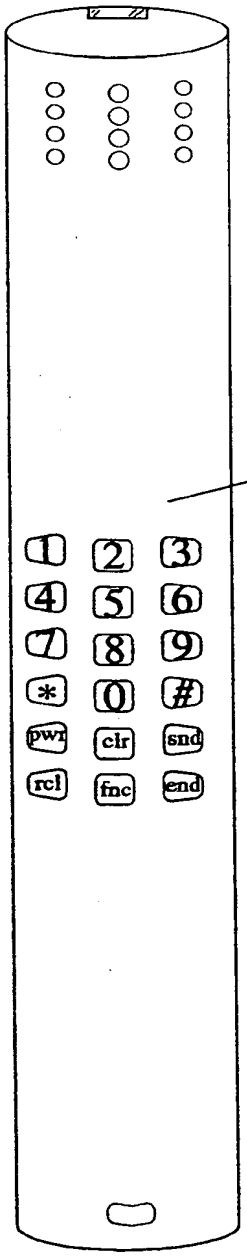


Figure 25(c)

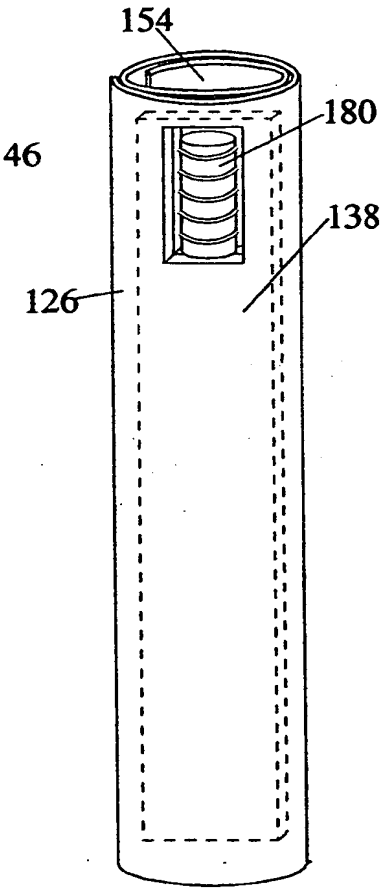


Figure 25(d)

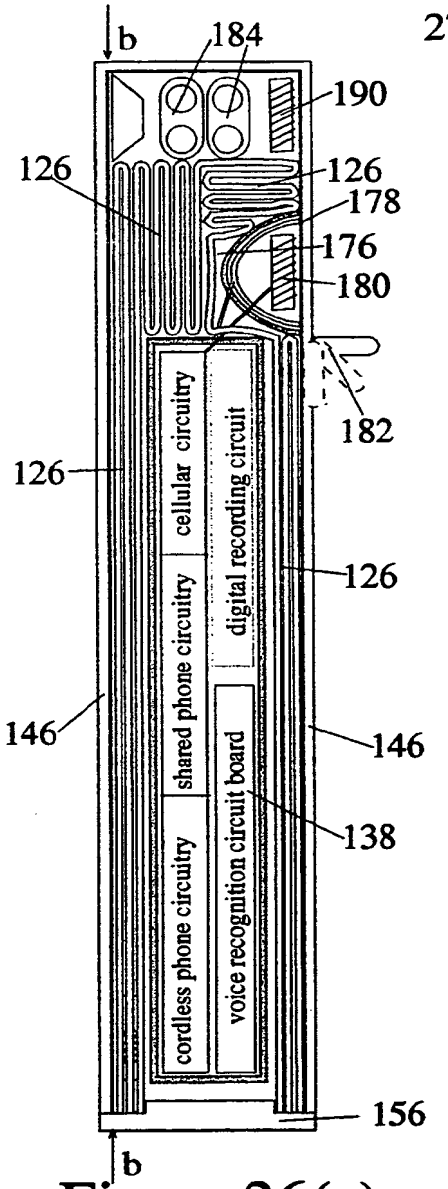


Figure 26(a)

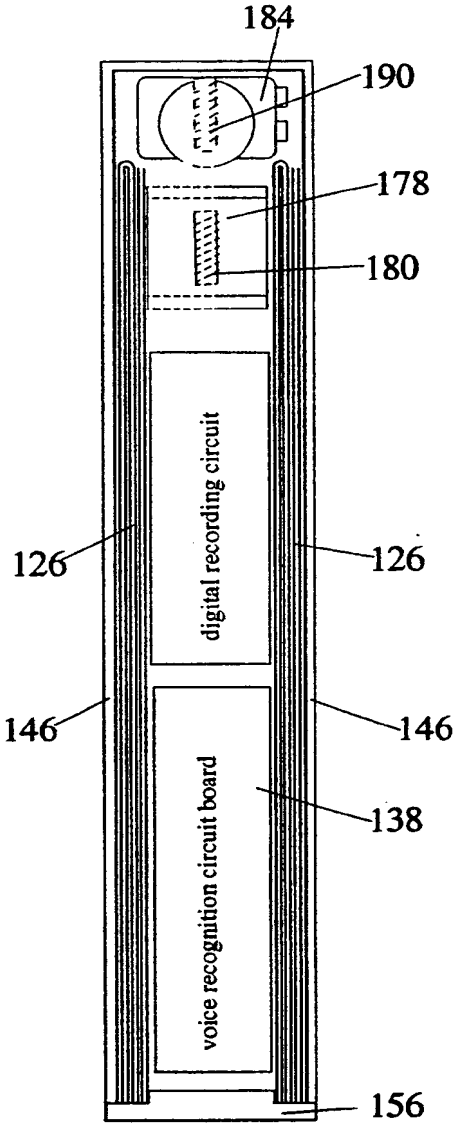


Figure 26(b)

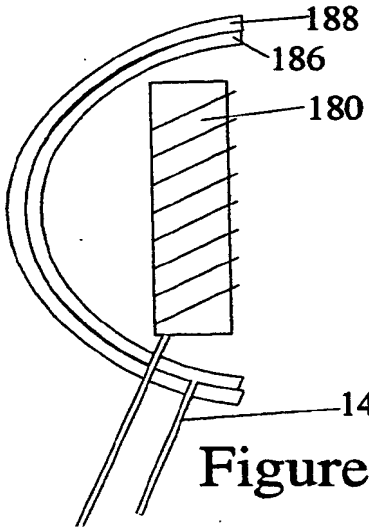


Figure 26(c)

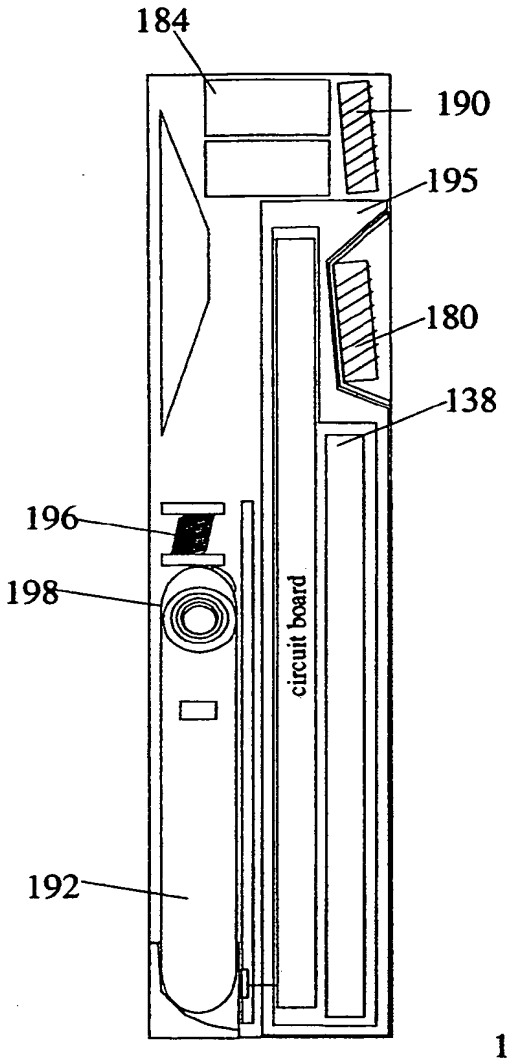


Figure 27(a)

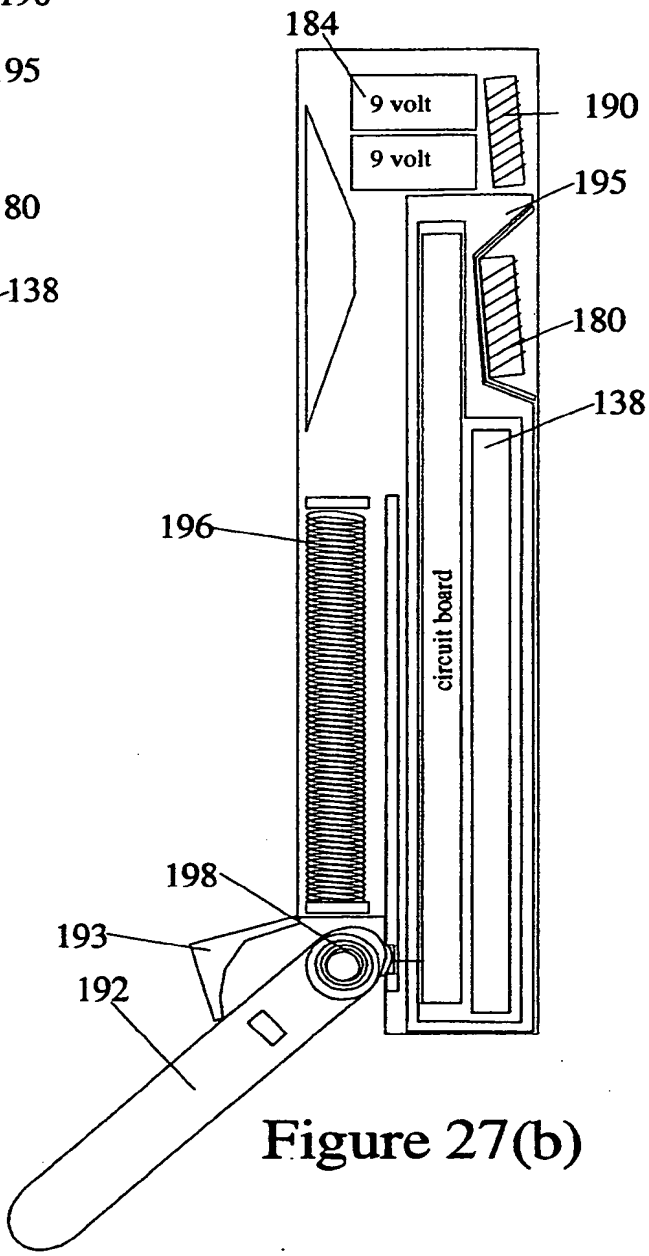


Figure 27(b)

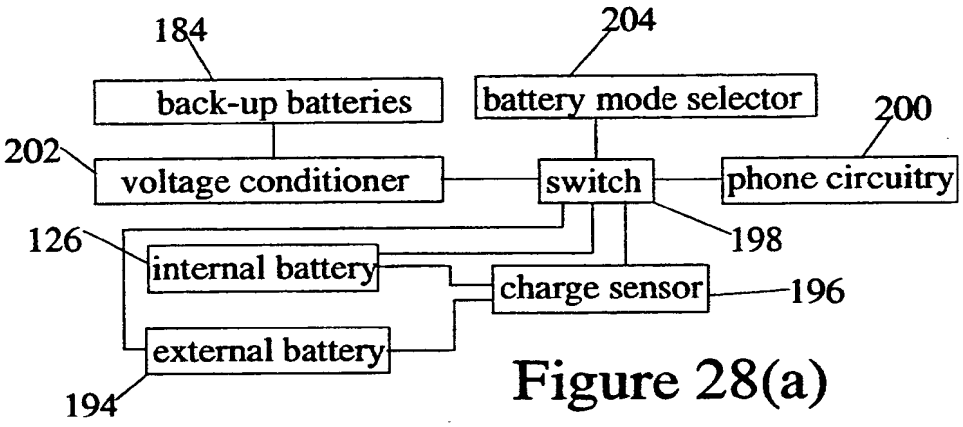


Figure 28(a)

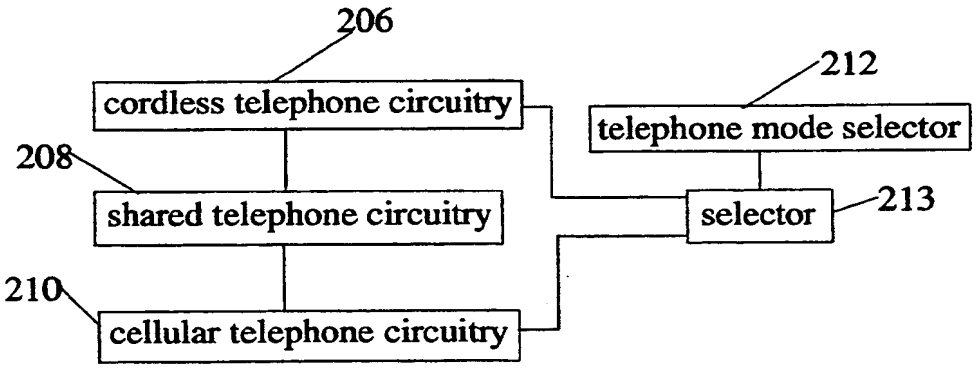


Figure 28(b)

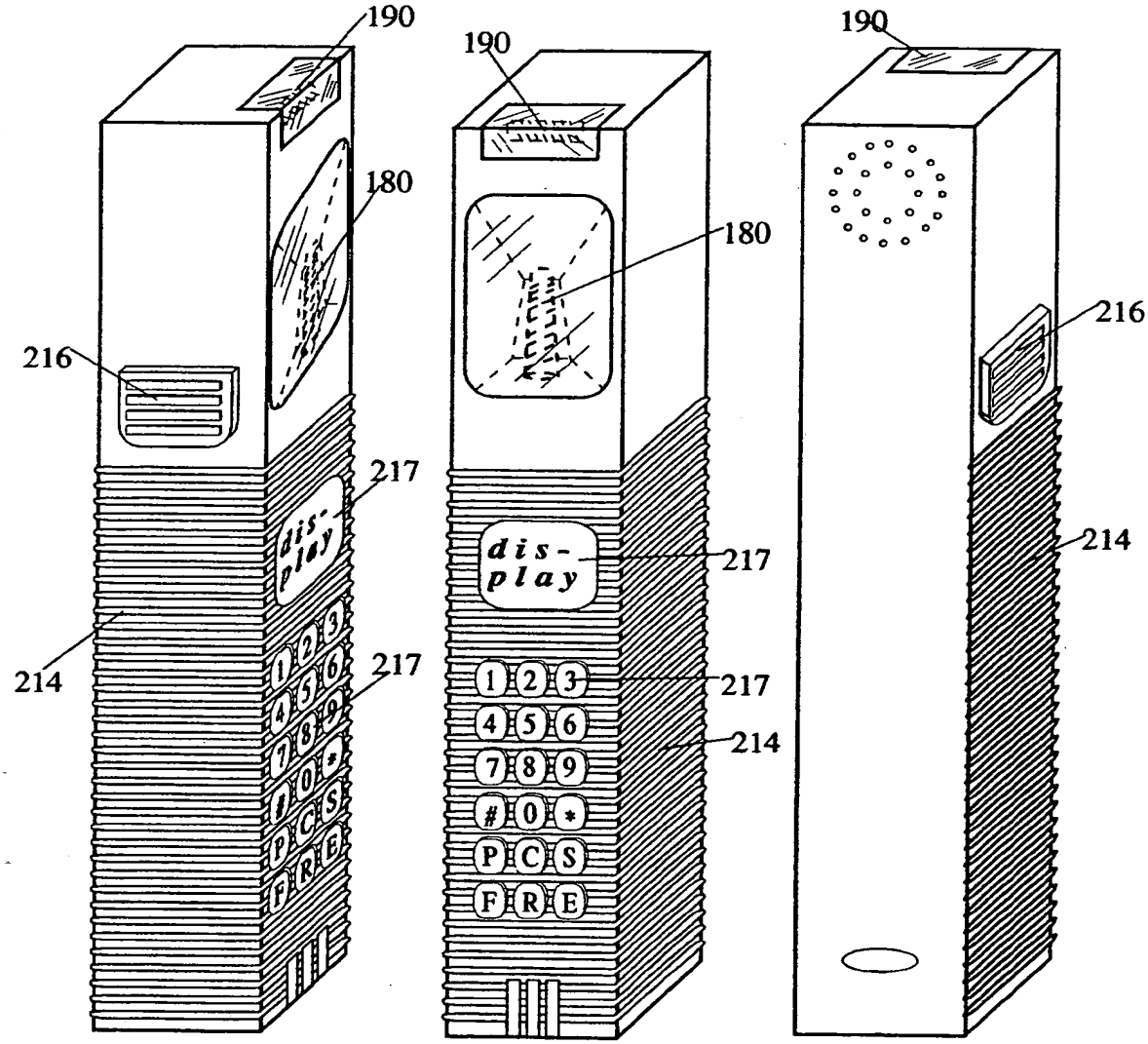


Figure 29(a) Figure 29(b) Figure 29(c)

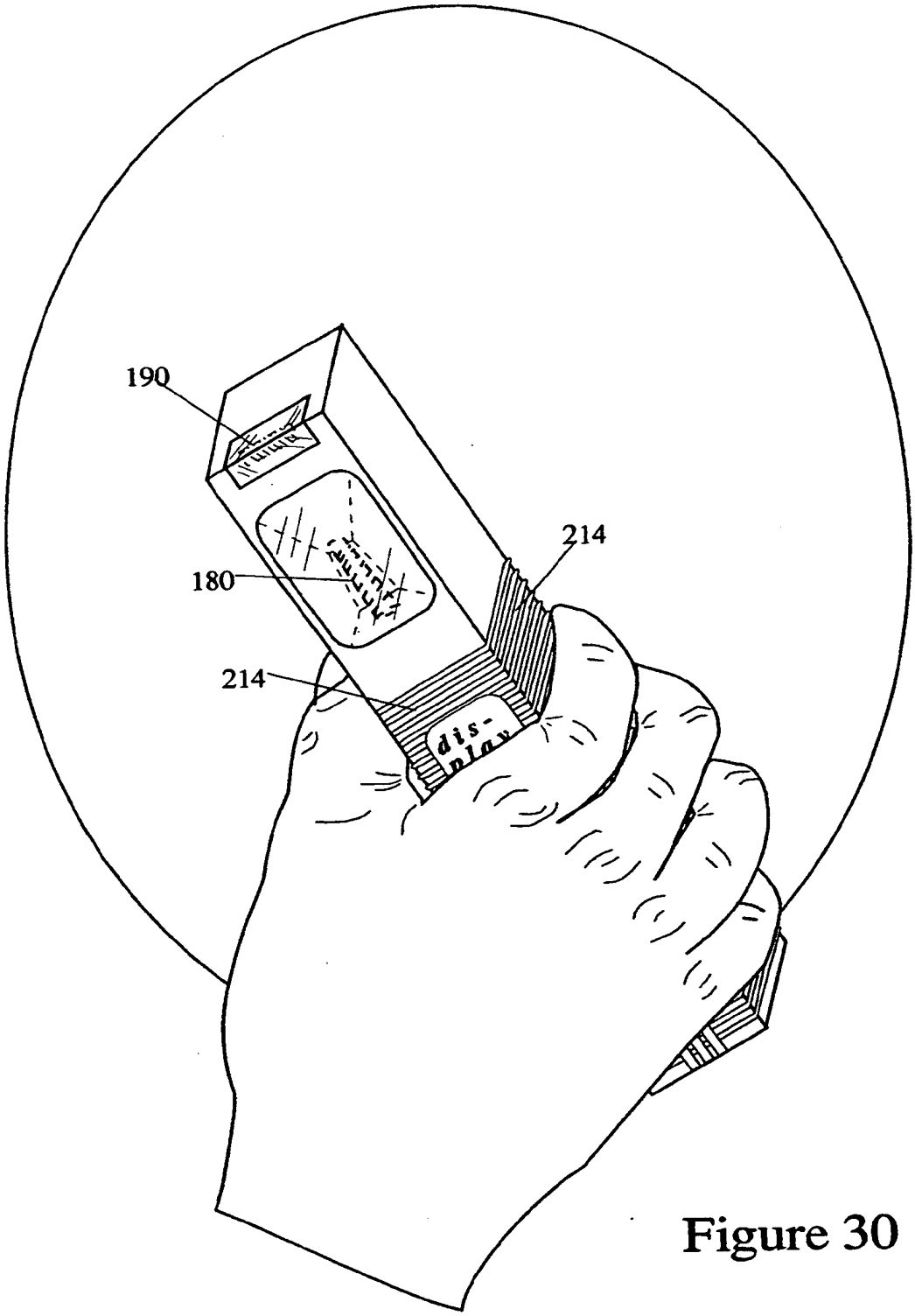


Figure 30

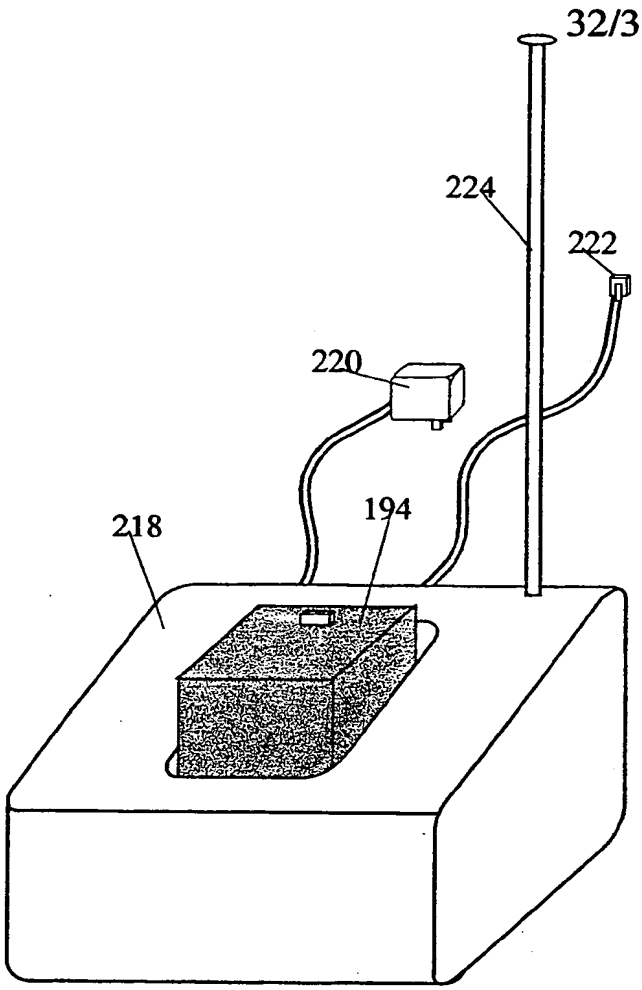


Figure31(a)

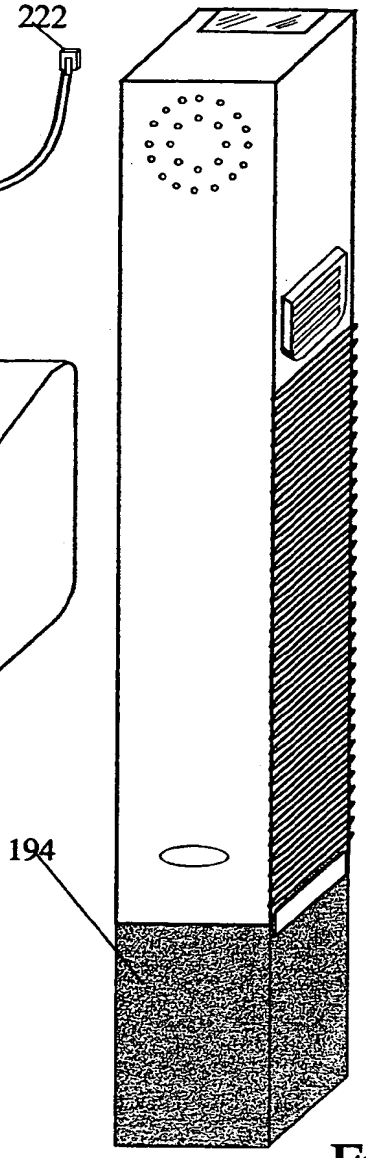


Figure31(b)

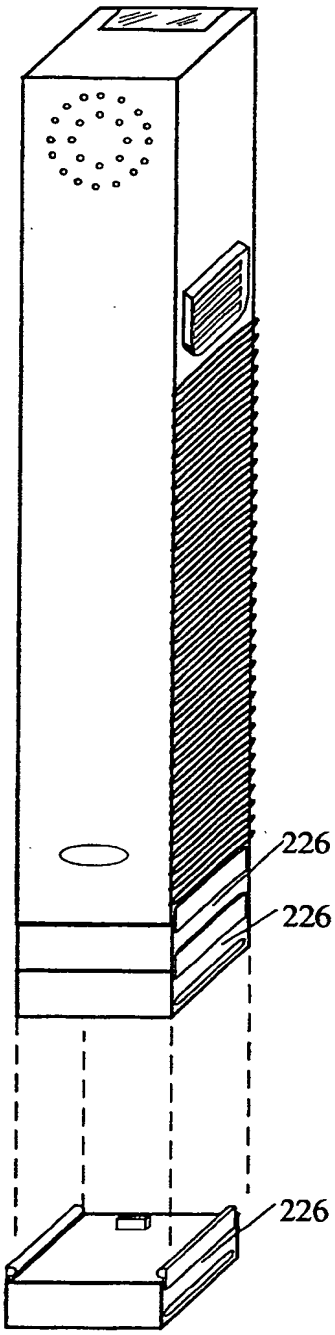


Figure 31(c)

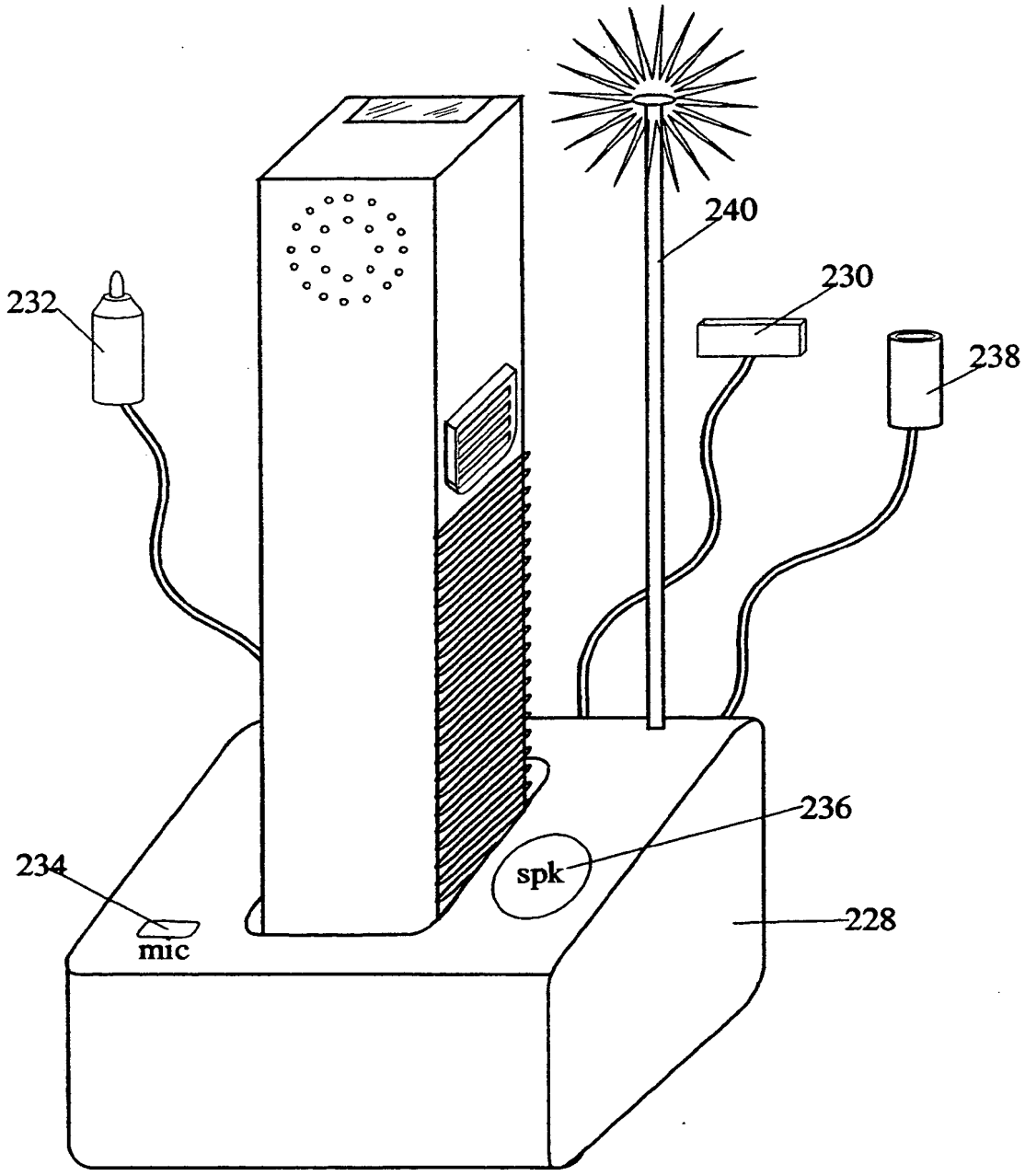


Figure 32

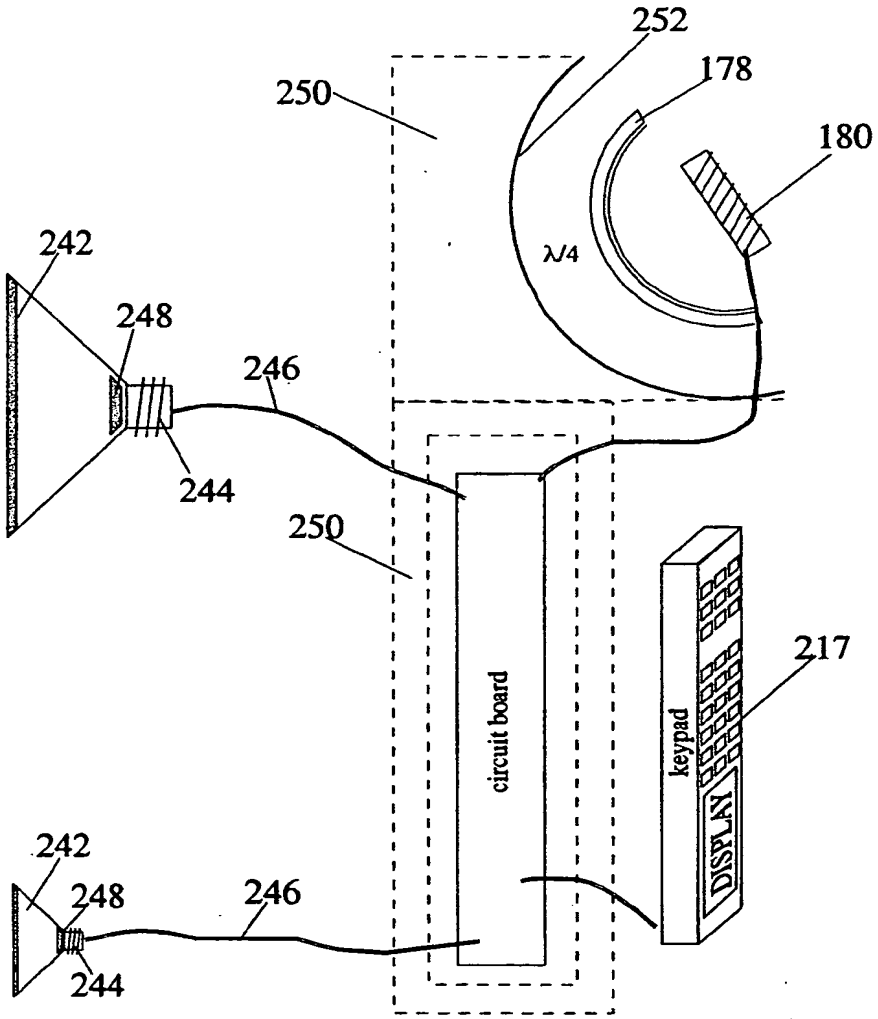

252
178
250
180
λ/4
242
248
246
244
250
circuit board
keypad
DISPLAY
217
242
248
246
244

Figure 33

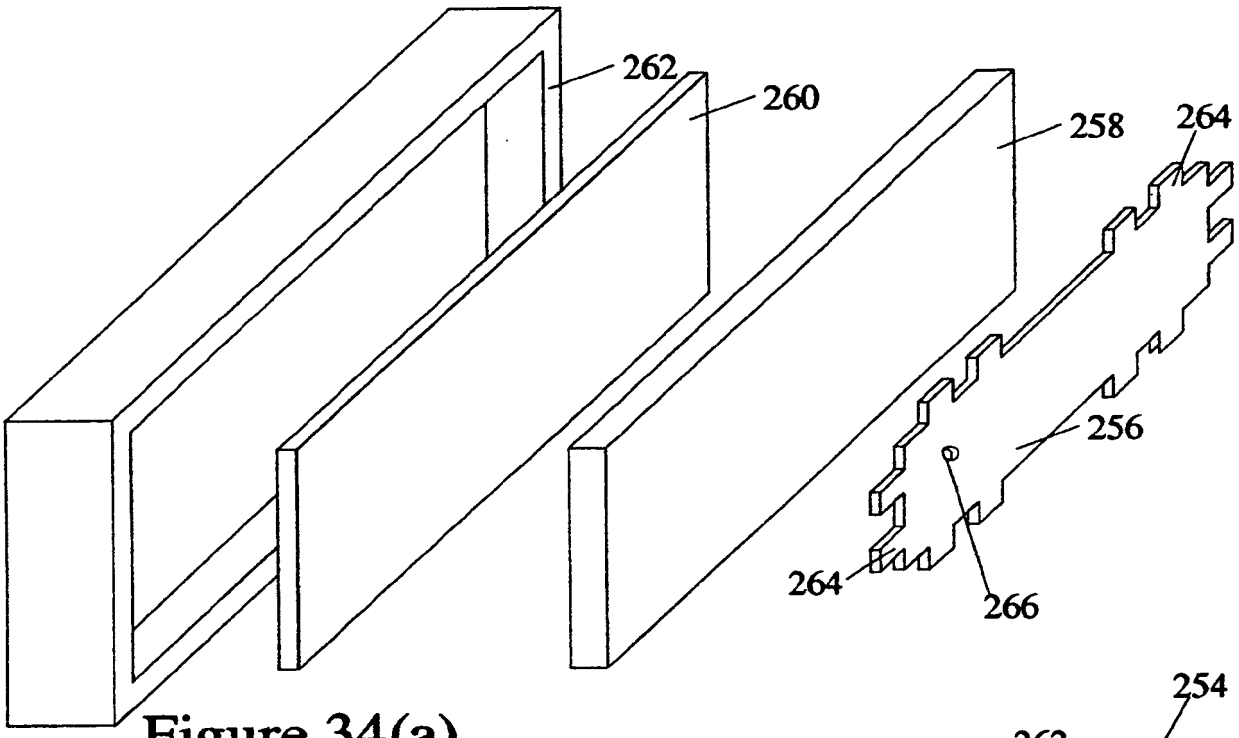


Figure 34(a)

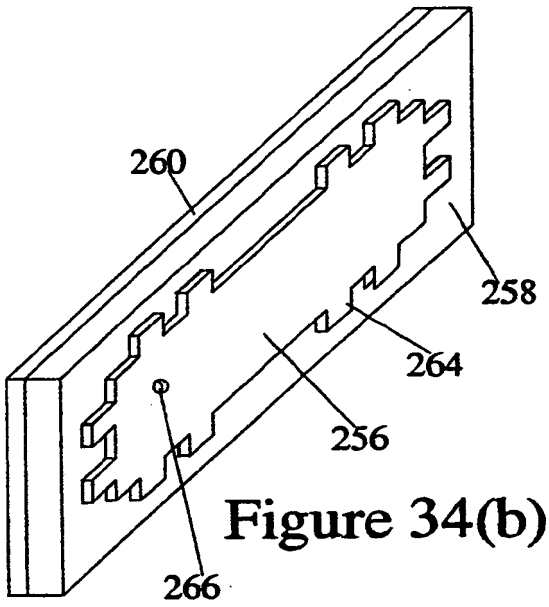


Figure 34(b)

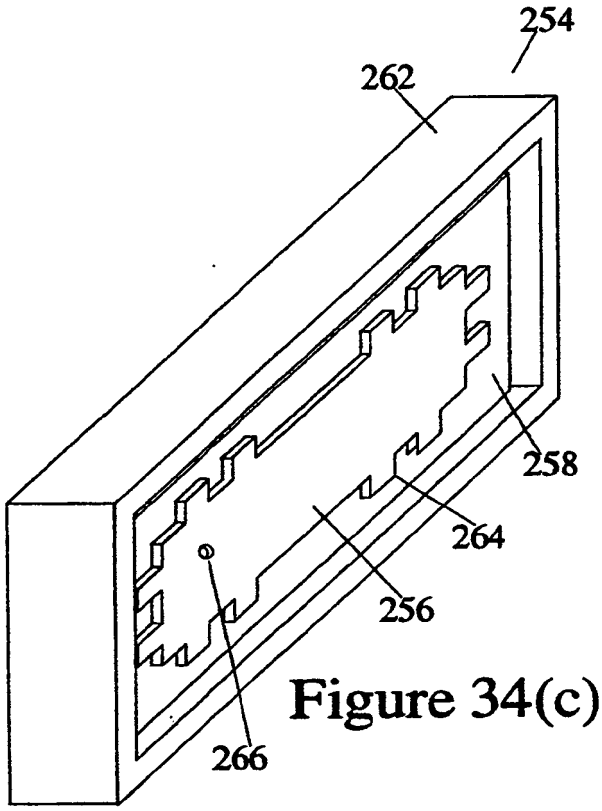


Figure 34(c)

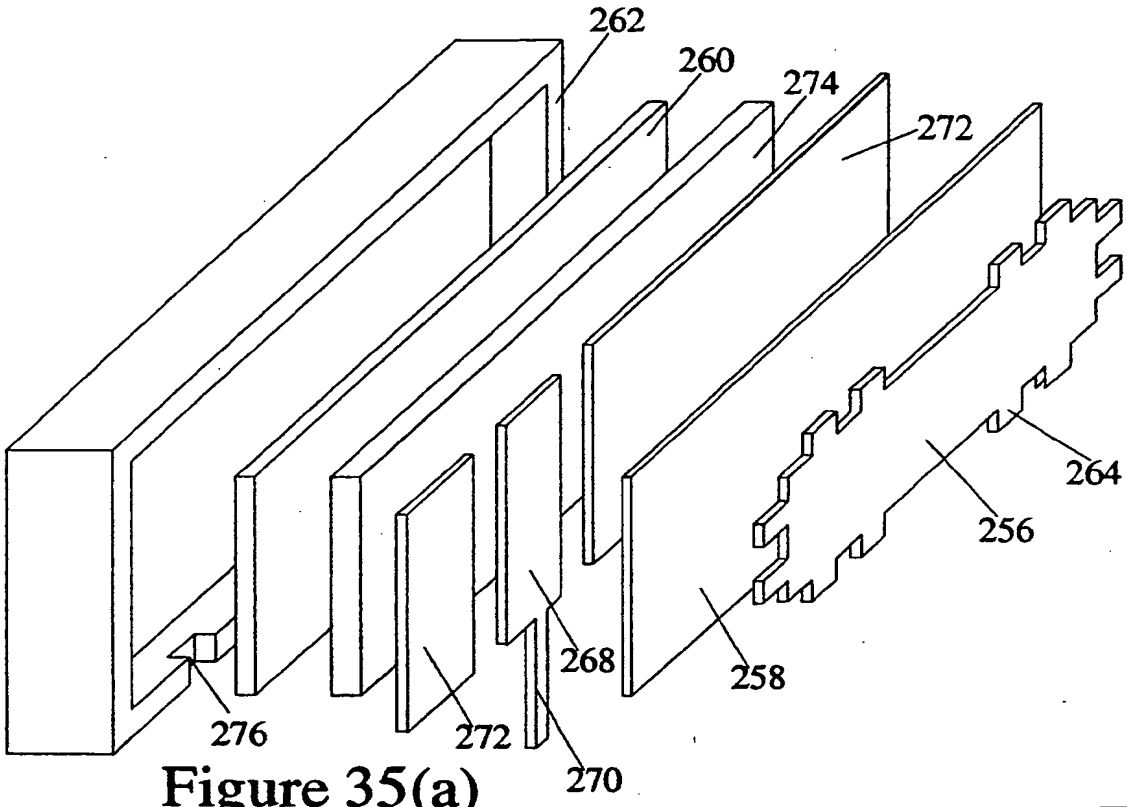


Figure 35(a)

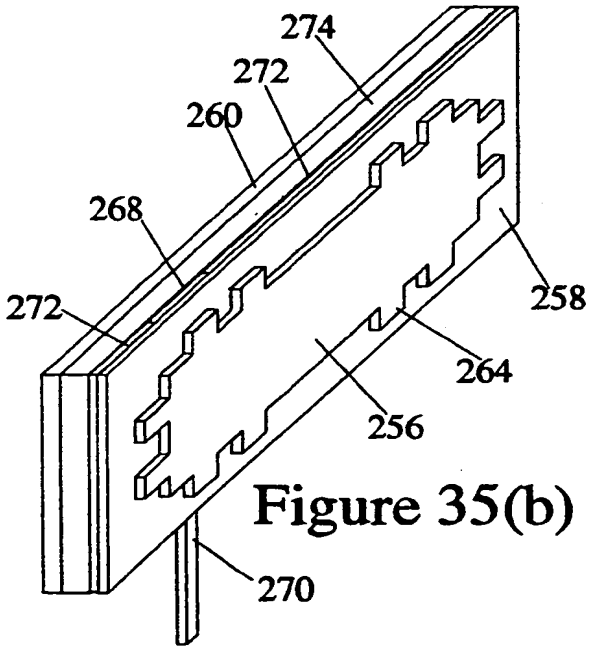


Figure 35(b)

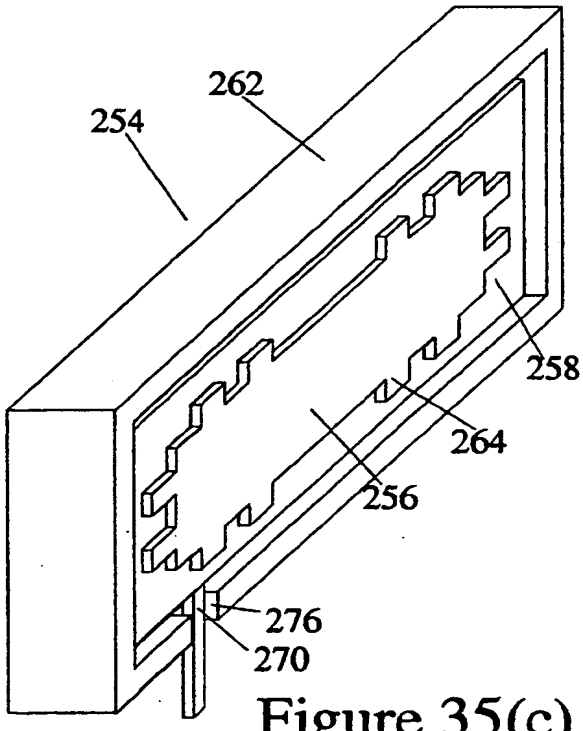


Figure 35(c)

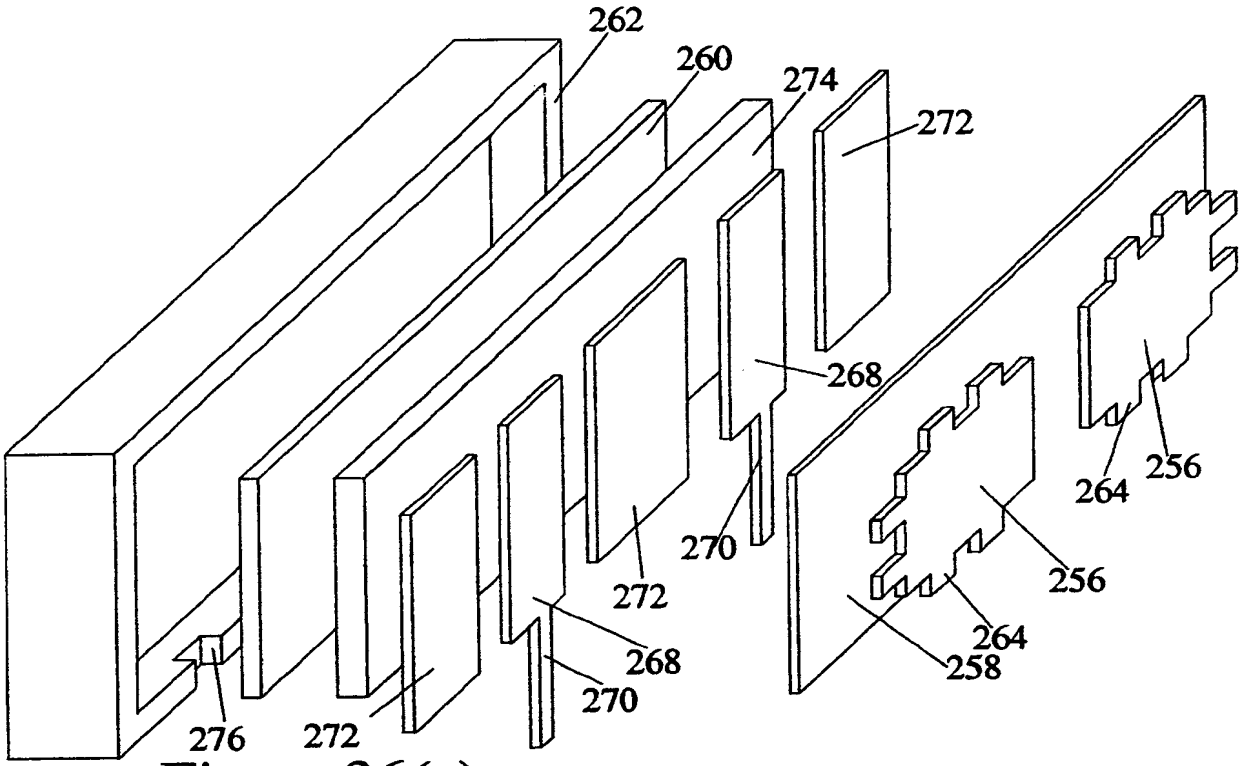


Figure 36(a)

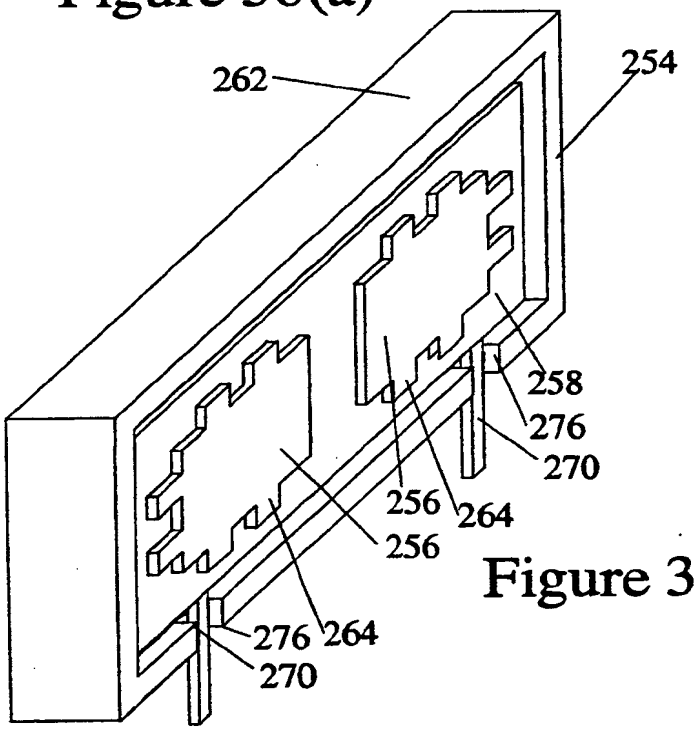


Figure 36(b)

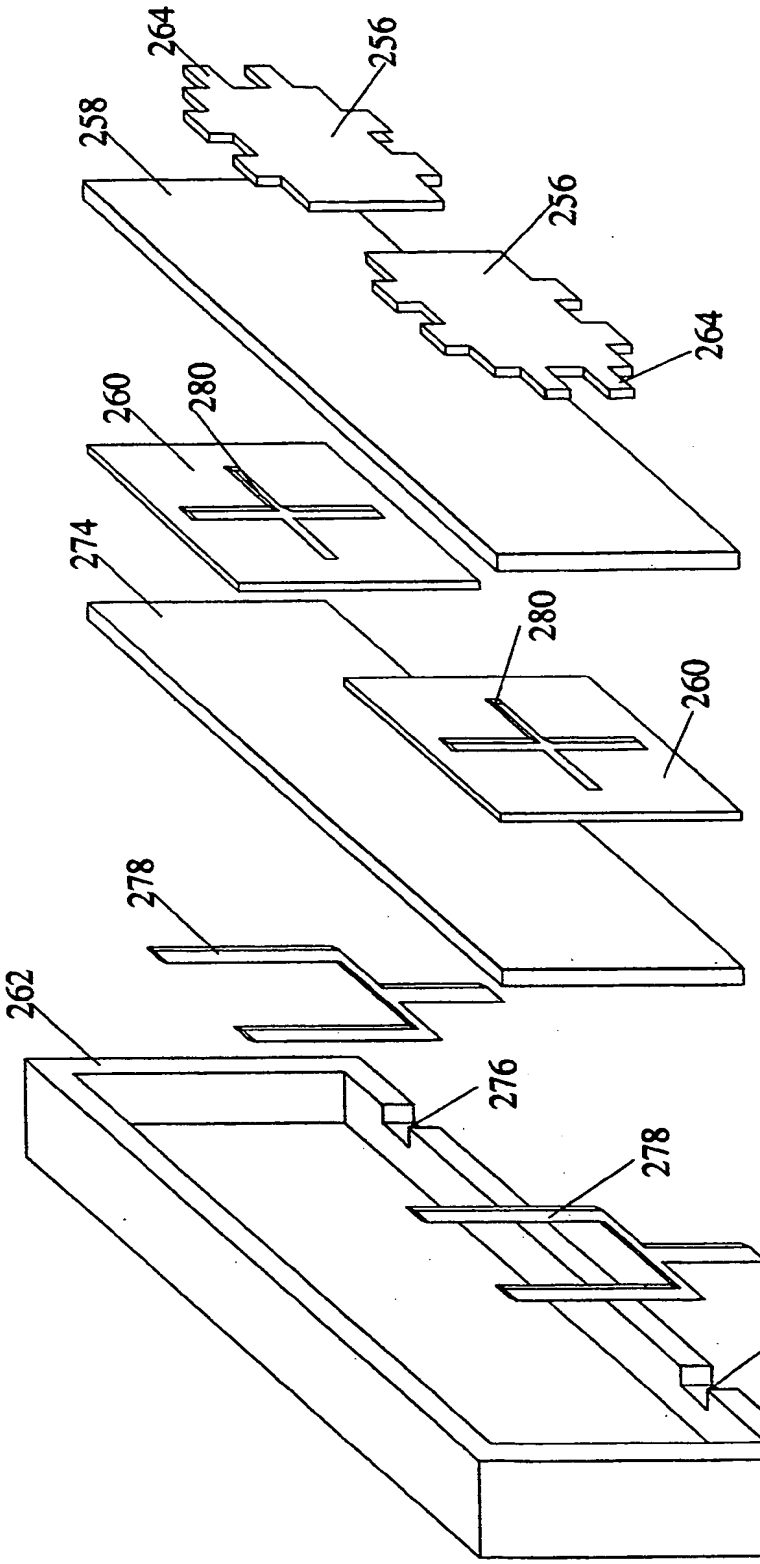


Figure 37

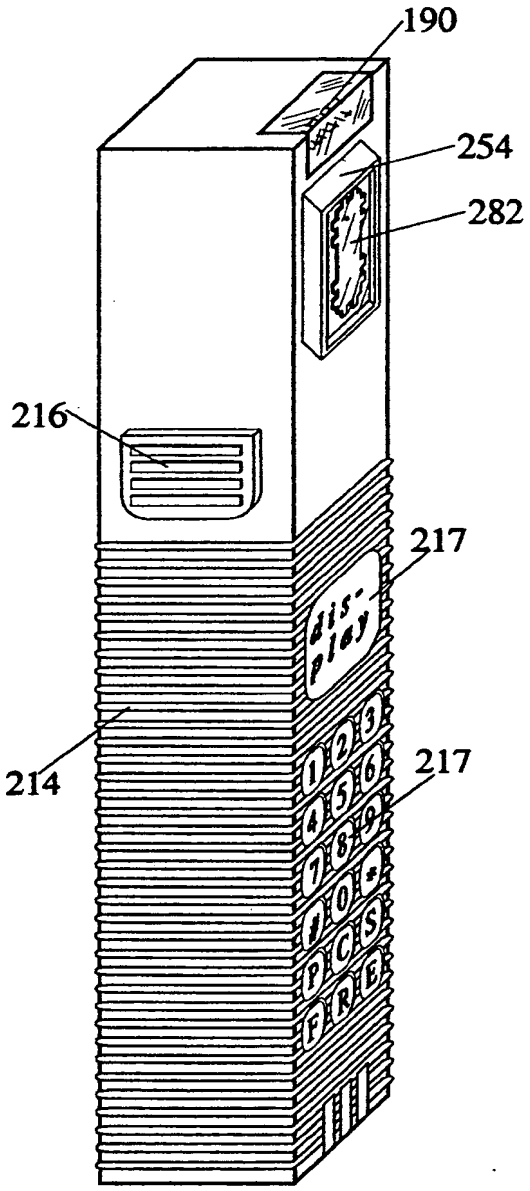


Figure 38

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/05866

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H04B 1/38
US CL :Please See Extra Sheet.
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 455/89, 90, 117, 129; 379/59, 433, 451; 174/35MS; 361/814, 816; 343/702, 841

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P --- Y,P	US, A, 5,367,309 (TASHJIAN) 22 NOVEMBER 1994 (see figure 4)	14-15 --- 1-13 and 16-20
X,P ----- Y,P	US, A, 5,373,304 (NOLAN ET AL) 13 DECEMBER 1994 (see figure 3	14-15 ------- 1-13 and 16-20
Y,P	US, A, 5,336,896 (KATZ) 09 AUGUST 1994	1-20
&	US, A, 5,335,366 (DANIELS) 02 AUGUST 1994 (see figures 1-7)	1-20

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be part of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
21 JULY 1995	18 AUG 1995
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer ANDREW FAILE Telephone No. (703) 305-4700

Form PCT/ISA/210 (second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

international application No.
PCT/US95/05866

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	IEEE Transactions on Antennas and Propagation, No. 6, June 1993, Toftgard et al, "Effects on Portable Antennas of the Presence of a Person", pp. 739-746	1-20

Form PCT/ISA/210 (continuation of second sheet)(July 1992)*

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US95/05866

A. CLASSIFICATION OF SUBJECT MATTER:
US CL :

455/89, 90, 117, 129; 379/433, 451; 174/35MS; 361/814, 816; 343/702, 841

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